Charles University in Prague

Faculty of Social Sciences
Institute of Economic Studies

MASTER THESIS

The Causes of Inflation in Mongolia

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Declaration of Authorship

The author hereby declares that he compiled this thesis independently, using only the listed resources and literature.

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Prague, May 17, 2013

Signature

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I am very grateful especially to the supervisor Roman Horvath Ph.D for guiding me through the topic and providing me with valuable comments and suggestion. I am also grateful to my family and friends for their care and love.

Abstract

In this thesis, we study the causes of inflation in Mongolia. We estimate a small open economy VAR model for Mongolia. The model comprises of two blocks - China and Mongolia and we impose a block exogeneity restriction in regards with our estimation purpose. We assess domestic and external shock affect on price level of Mongolia using impulse response function and reveal the main contributors to the price variability utilizing the forecast error variance decomposition (FEVD). Therefore, we trace out that the external shocks affect the price significantly in comparison with the domestic shock. In addition, we can say that the price level is very susceptible under the supply side shock.

Keywords Inflation, small open economy, structural vector autoregression, block exogeneity

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Master Thesis Proposal

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Notes: The proposal should be 2-3 pages long. Save it as "yoursurname_proposal.doc" and send it to mejstrik@fsv.cuni.cz, tomas.havranek@ies-prague.org, and zuzana.irsova@ies-prague.org. Subject of the e-mail must be: "JEM001 Proposal (Yoursurname)".

Proposed Topic:

The Causes of Inflation in Mongolia

Topic Characteristics:

Mongolia is a typical developing country, which depends heavily on resource-based exports and its economy is considered as small open economy, highly dependent on foreign trade. For recent 15 years, average inflation rate has been 10% and its average standard deviation has estimated over 10%. Currently, inflation rate in Mongolia is 15.2%, which is relatively high and volatile, and one of the urgent issue in Mongolia. During the global financial crisis of 2008-2009, inflation rate reached to 34.2%. Thus, we can see how volatile inflation is in Mongolia. The whole economy is becoming vulnerable and weak because of high and volatile inflation. In addition, the Bank of Mongolia put the goal to hold the inflation rate in single digit, but so far it is not implementing. Concerning those inflation issues, I wanted to study about the inflation.

There are many studies about the inflation but I find that scarce of literature related to the foreign shock affect to the price level. Moreover, my curiosity about the Chinese influence on the Mongolian price level motivated me to study the domestic and foreign shock affect to the domestic price level. I would explore which shock is more significant on the price level of Mongolia and try to determine main shocks whether it is supply side or demand side etc.

I am going to use the data from the Bank of Mongolia and National Statistical Office of Mongolia and other available sources.

Hypotheses:

1. External shocks have more significant influence on the domestic price level.

2. Both supply and demand side shock have stronger influence on the price level.

3. Monetary policy shock is less significant to compare other shocks.

Methodology:

I am going to employ a small open economy VAR model in my thesis. Once many variables do affect on the inflation, the VAR model will help is to capture their interrelationship with the price level. In addition, by employing VAR model we will be able to recognize the price response to the different shocks and compare them with ease. By the way, the VAR model is advantageous which tells us time specification. Those reasons lead us to utilize the VAR model.

Outline:

1. Introduction

2. Related literature review

3. Theoretical model

4. Empirical model

5. Empirical result

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Introduction

Inflation is considered one of the urgent issue in Mongolia once we have experienced very high and volatile inflation rate during the last decades. It is a small open economy country, which is highly dependent on the resource based exports and foreign trade. Volatile and high inflation rate makes an economy vulnerable and creating big pressure on the people life in Mongolia. The Bank of Mongolia sets a goal to hold inflation in one digit, but no more effect in the reality.

In this thesis, we focus on the causes of inflation in Mongolia. Recently, many studies explore the underlying reason of inflation such as Barnett et al (2012), Batnyam et al (2007), and Batsukh (2008). The study of Barnett et al (2012) concludes that international price movement affects inflation significantly, especially on food price. Moreover, they stated that higher fiscal spending through wage and excess demand cause in the price movements. Batsukh.Ts (2008) states fuel price movement and neighbor countries price level are the main determinants of the inflation in Mongolia. Batnyam et al (2007) also studied the inflation process and formulated the Small Inflation Model of Mongolia (SIMOM) as a main model of Bank of Mongolia (BOM) for analyzing the monetary transmission mechanism and studying the inflation process.

Therefore, considering such an outstanding research work, we employ a small open economy VAR model with a block exogeneity restriction. We have two blocks in the model; China and Mongolia. We choose China so that it is our main trade partner and it accounts over 92.2% of total export[1] and 30.7% of total import. The small open economy VAR model is mostly utilized

[1] *Source: National Statistical Office of Mongolia (2011)*

for the studies of monetary transmission mechanism. Although, we are curious about how the inflation of Mongolia is explained by this model. But some already applied this model for assessing the external shock impact to the domestic price level such as Krznar and Kunovac (2010). By applying this model, we are able to see how the domestic and the foreign shock affect the price level of Mongolia and which shock mainly stimulates the inflation. We assume that Chinese shocks have significant affect on the domestic price. Our main findings indicate that the external shocks have more significant effect on the price level in comparison with the domestic shocks. More specifically, domestic supply shock has significant effect on the price among the other domestic shocks while the most of the external shocks affect the price substantially. Thereby, we conclude that the domestic economy is susceptible under the external shocks.

Inflation process is one of the most explored topics among the economists of Mongolia. Even though, there is no particular research work utilized the small open economy VAR model with two countries block and explore the external shocks affect on domestic price. Thereby, we would contribute our research filling this gap of literature in the inflation studies of Mongolia.

The rest of the thesis is organized as follows: Chapter 1 discusses the related literature review. Chapter 2 presents the theoretical background of the model while Chapter 3 focuses on the empirical model-Small Open Economy VAR model. Empirical results are presented in Chapter 4. We introduce our final conclusion in Chapter 5.

1. Literature review

We outline the literature review part as following sequences. First of all, we briefly discuss about the complementary inflation theories to shed a light on what factors basically causes inflation. Here, we pick up six competing theories such as monetary, demand pull and supply etc. Secondly, we focus on inflation analysis of small open economy which can be considered as the similar case of our research subject. Third, we deliberately take into account Mongolian inflation related research works. Lastly, we expand our literature review by studies of Structural Vector Autoregression (SVAR) model since we employ it in our research work. Specifically, we focus on the works which utilized a small open economy VAR model. Besides the SVAR model literature, we also focus on the works which studied impact of foreign shock to the domestic inflation.

1.1 Macroeconomic theories of inflation

Theoretically, we can classify the origin of inflation into 6 schemas including monetary shocks, demand or supply side shock, structural and political shock. Inflation is mostly explained by the combination of those shocks even one shock also dominantly influence on inflation. On the other hand, it is appeared as a result of their dynamic interaction. Therefore, we introduce below the basic inflation theories.

The Quantity Theory Of Inflation: Classical (eg.,. David Hume, Adam Smith, David Ricardo) and neo classical (David Hume, Adam Smith, David Ricardo) economists explain inflation using the quantity theory of money. It states that total volume of money in the economy is equal to the

general price level of goods and services multiplied by the level of real output. So, excess supply of money in the economy causes increased inflation.

Demand Pull Theory: Keynes (1940) developed "Inflation gap" model as one alternative demand side approach to inflation. They argued that the increase in aggregate demand as the source of demand-pull inflation. The aggregate demand comprises of consumption, investment and government expenditure while it expands by net export in open economy. The aggregate demand exceeds than the aggregate supply at the full employment level, it results the inflationary gap to raise. The bigger gap means the higher inflation.

Monetary Theory of Inflation: Monetarists, Milton Freedman as a main representative, argue that the money supply is the dominant, but not exclusive determinant of both output and price level in the short run. But in the long run, only the price level is influenced by the money supply, not the output level. Monetarists assert that inflation is always and everywhere a monetary phenomenon that arises from a more rapid expansion in the quantity of money than in total output. The monetarists employed the familiar identity of exchange equation of Fisher.

Supply Theory: The other approach to inflation is named cost-push inflation which propagated from increase in money wages or. Higher wage resulted as a higher price in product once firms run for profit making. Eventually, it leads general price level increase in whole economy. This sort of inflation was the pivotal cause of inflation during 1970s.

Structural Inflation Theory: The term "structural inflation" entered in an economic discussion around 1970s. It mainly deals with structural factors of inflation causes of government activities.

Rational Expectation Theory: Rational Expectation theory was revolutionary in the field of macroeconomics during the 1970s by Lucas, Sargent and Hansen. They argued that people do

not make the same mistakes consistently and their expectation is based on the past information and currently available information as well. According to the RE approach, once every economic agent has rational expectation, the monetary policy can be fully anticipated and will not have real effect on inflation even in the short run. So, this school suggests that the Central Bank should make some price surprise, it is the way to affect real GDP etc. Moreover, Sargent and Wallace stated that the government budget deficit can create unavoidable inflation.

The New Neoclassical Synthesis plays pivotal role in the studies of monetary policy. This theory basically flourished from the Keynesian view and Neoclassical principle to the macroeconomic analysis. It is popularized around 1990s while the other approaches to business cycle and price movement explanation started deteriorate. NNS economists noted that monetary or demand side factors are keys to determine business cycles. New version of NNS model, IS-LM-PC, is introduced to the field of macroeconomic made big contribution. In this model, IS refers to Investment and Saving, LM is assigned by equilibrium equation of money market while PC refers to Philips curve.

New Political Macroeconomics of Inflation view takes into account the non-economic factors for explaining inflation process. Non-economic factors refer to institutions, election and culture etc. They argue that there are some linkage between inflation cause and timing event which mainly relates to the important political decision. The Center Bank independence relates to the monetary policy as far as for inflation. They also argue that protracted budget deficit can be cause of inflation.

1.2 Inflation studies of Small Open Economy

The general consensus states that the developed countries inflation causes more likely explained by monetary process while the demand and supply shock are named as the main causes of inflation in the developing countries. Therefore, we discuss here the several developing country inflation studies.

Negro and Schorfheide (2008) analyzed inflation dynamics responding to the external and internal shocks in the case of Chili. In addition, they also focused on how the dynamic responses react under various policy parameters. They employed small open economy Dynamic Stochastic General Equilibrium (DSGE) model for the estimation. DSGE-VAR methodology is applied for robustness check of the conclusion. They are left with following results from empirical analysis. First, the Chilean Central Bank does not react in a significant way to exchange rate and trade movement terms. Secondly, they suggest that employing VAR estimates can be useful because it deals with restrictions generated by DSGE model. Third, they noted that observed inflation variability is dominantly due to the domestic shocks based on both estimation of DSGE and DSGE-VAR. Finally, they concluded that DSGE model may not impose some important policy trade-offs hence it has many restrictive assumptions. Therefore, this model is poor to deal with many parameterized model and outcomes of this model are not robust. They also referred that applying DSGE-VAR methodology can be useful at Central Banks once it provides ways to check robustness of policy advice under various assumptions about misspecification.

New Keynesian Phillips Curve is determined currently the most influencial model for infaltion dynamincs. As Vašíček (2009) focused on infaltion dynamics of four new EU member states including the Czech Republic, Hungary, Poland and Slovakia under employing New Keynesian

Phillips Curve (NKPC). He applied empirical framework of GG and GGL (Galí and Gertler, 1999, and Galí, Gertler and López-Salido, 2001) and used rational expectation GGL framework, too. He found some evidence that states current inflation is determined by future inflation expectation and output gap can be inflation forcing variable. Moreover, they noted that most of inflation variance seem intrinsic while short term inflation impulses come from external in NMS. He noted their main findings as follows. First, inflation process in NMS has backward-looking component calls. Second, monetary policy effect on inflation goes via marginal cost (output gap). Finally, he concluded that inflation dynamics of EMU members are very consistent with the NKPC.

Durevall and Ndung'n (2001) analyzed Kenya inflation dynamics between the years of 1974-1996. They employed Error-Correlation model and concluded that restrictions on monetary factors and food supply are the main causes of inflation in the short run while the external factors play in main role in the long run.

Lendvai (2005) studied Hungarian inflation dynamics between 1995-2004. She estimated Phillips curve and noted that imported goods can be good explanation of inflation dynamics. She employed tradition Phillips curve and the standard New Hybrid Phillips curve to compare Hungary and Euro area inflation dynamics and concluded that inflation in Hungary is more inertial than Euro area inflation. Moreover, she found that inflation is more likely the result of backward looking price setting and the weight of lagged and expected inflation role are seemed equally.

Monem (2011) analyzed inflation dynamics in Egypt during the period of 1980-2009 and employed VAR model. He noted that inflation of Egypt became more persistent to the external

shocks especially from 2000. Moreover, inflation rate raises steadily, not rapidly. During 1980, demand pull inflation pressure existed due to the increased liquidity to the budget deficit and from 1990 inflation main pressure is determined as a exchange rate pass through effect while in 2000 inflation causes was mainly combination of supply and demand pull inflation and even budget deficit. He also noted that inflation becomes more reactive to supply side shocks from 2006. Finally, he stated that managing the budget deficit can be one manipulation of inflation from the side of the government.

Hess and Schweitzer (2000) asked that increased wage causes the price inflation. They employed Granger-Causality test and used data from US covering the period between 1960Q1 to 1999Q3. They found a little evidence that increased wage causes increased price inflation. Controversially, they stated that higher price can be resulted to higher wage.

Mihailov et al (2009) focused on the small open economy New Keynesian Phillips Curve to make some empirical assessment by employing GMM estimation method. The data covered the OECD countries, Germany, France and UK. They noted that ToT expected changes have more significant affect on consumer price inflation (CPI) than simultaneous domestic output gap. Moreover, they noted that one third of the sample countries susceptibility to the external shock increased over time and they mentioned that globalization can be one of the reason of such a phenomena.

Santacreu (2005) asked that the Central banks of a small open economy should react to consumer price index inflation or impose on multisectoral structure of economy. She employed a structural general equilibrium model and applied Bayesian techniques in the case of New Zealand, the country considered as a small open economy. Further, she divided the economy into non

tradable and tradable for the model and assumed that loss function where the central bank takes account into inflation, output gap, and exchange rate movements. The result of this study states that the central bank responds to consumer price index inflation and exchange rate movement is not that significant to be in consideration. In addition, she noted that there are some conditions where the central bank makes some reaction to the non-tradable inflation, not covering whole inflation.

Jiranyakul and Opiela (2009) studied the correlation between inflation and inflation uncertainty in ASEAN-5 countries which includes Indonesia, Malaysia, Philippines, Thailand and Singapore covering the period 1970Q1-2007Q4. They applied conditional variance in an AR(p)-EGARCH (1,1) for estimating inflation uncertainty and Granger causality test is used for testing inflation causes the inflation uncertainty or vice versa in given countries. As a result, they stated that inflation can be result of inflation uncertainty and uncertainty can be the reason of inflation even those countries have relatively low inflation to compare other emerging market. They also noted that there should be better monetary stabilization in those countries as if the inflation raises uncertainty about upcoming inflation rate.

Panagiotidis and Triampella (2005) focused on the relationship between Central Bank Independence and inflation rate in the case of Greece. They assumed that CBI is related to the inflation and they used time series approach for examination. They employed two indices, Legal CBI and TOR, for examining the relationship. As a result, they stated that inverse relationship between CBI and inflation has observed. So far, they argued that higher independence in CB and less frequent changes in CB CEO followed by the lower inflation in the case of Greece.

Josef et al. (2010) studied Ethiopian inflation dynamics over the past decades. They aimed to trace out significant contributors to the consumer price index inflation and named them as cereal prices, food prices and non- food prices as pivotal players in inflation raises. Moreover, they stated that global market price of good and food influences domestic price increase in the long run while in the short run, agricultural supply shock is key factor to inflation. Hence the weight of food in CPI is high, the inflation in Ethiopia is subject to the food price. Money supply is considered as main causes of inflation but mainly in the short run. Based on their study, they suggested conduct monetary policy more effective in the way of financial sector improvement by doing this, their domestic inflation could have some second round protection.

1.3 Inflation studies in case of Mongolia

Many economists try to explain the causes of high and unstable inflation rate in Mongolia. In this part, we introduce the inflation related research works which are considered the most notable. Khulan.A (2005) determined the principle causes of inflation utilizing Philips curve and Granger test. Her research result indicates that both M2 money supply with 4 months lags and exchange rate fluctuation with 1-3 months lags influence on the inflation. Notably, she also states that PC estimation result showed no significance of output gap on the inflation. So, she explained this result relating to the shadow economy. Enkhhuyag (2001) tried to estimate money supply influence on the inflation. He estimated it by Ordinary Least Squares and noted that money supply influences on the CPI with twelve months lags.

Gan-Ochir.D and Borkhuu.G (2002) focused on the correlation between inflation and some monetary variables and they employed ARIMA and VAR models for their estimation. Their result showed that money aggregation, exchange rate, policy rate of Bank of Mongolia (BoM), one year lagged inflation rate all have some influence on the inflation but the exchange rate

affect was very strong among others. The weakest influence on the inflation was policy rate and money supply. Also, Gan-Ochir (2005) studied the correlation between the wage (other income) and inflation in Mongolia. He asks that higher wage of state owned institutions resulted higher rate of inflation or vice versa. He employed Cointegration and Granger-causality test. As a result of estimation, he noted that in the long run, 10% increase on the wage resulted 4.45% increase on inflation. Increase wage raises inflation after one quarter while inflation causes increase in wages after 2 quarter. Increase in wage raises inflation after one quarter while inflation causes wage to increase after 2 quarters.

Batnyam.D et al (2008) introduced SIMOM model for predicting inflation of Mongolia. This model comprises totally 10 estimated regression model such as IS, LM regression, exchange rate regression, Philips curve etc. This model is used to analyze the monetary policy transmission mechanism, inflation propagation, and some macroeconomic indicators response to medium term shocks. Their result shows that the inflation of Mongolia is not persistent to internal and external shocks and monetary policy transmission mechanism is weak. Therefore, they noted that exchange rate channel is the most efficient one among Mongolian monetary policy transmission channel.

Barnett et al (2012) studied inflation of Mongolia. They utilized VAR model to see how shocks propagate. As a result, they trace out that underlying inflation is highly hit by aggregate demand shocks, while food price is subject to both demand and supply shocks. They also estimate a Philips curve relationship based on Bailliu et al (2003) and concludes that output gap is significant impact on the inflation, while nominal exchange rate change does not have significant effect on the inflation in Mongolia.

Batsukh.Ts (2008) analyzed the inflation causes of Mongolia covering the period of 1996-2007. He analyzed money supply structure, government institution wage, exchange rate, fuel price, foreign trade, and neighbor countries inflation respectively. Notably, he generally concluded that money related factors influence on inflation is smaller than other factors. Some of his research results are named below: increase in wage from 1995 significantly influenced inflation since its wage growth rate is bigger than inflation rate; Fuel price movement is one of the main determinants of inflation; Inflation rate in Mongolia also depends on two neighbors (China and Russia) inflation rate once those are the main trade partners.

1.4 Utilizing a SVAR model for inflation analysis

We focus carefully on the papers of Structural Vector Autoregression (SVAR) model since we employ it on our research. More precisely, we are interested in how foreign shocks affect the domestic inflation. A small open economy VAR model usually applied for studies of monetary policy transmission. But some already applied this model to check the impact of foreign shocks to the domestic inflation. We can name Giordani (2004) and E.O.Svensson (2000) as our main benchmarking works on the both of theoritical and empirical part.

Giordani (2004) analyzed affect of the foreign shocks to a small open economy and focused on their response to shocks. He employed New-Keynesian models for a small open economy and estimated it by SVAR model. US and Canada were chosen as an empirical estimation sample pair. As a result, he concluded that US shock does affect the Canada variables. For example, US technology shock has some effects on Canada output and positive US productivity shocks do not approach the US dollar to depreciate. In our work, we focus how Chinese shocks affect on the domestic inflation.

Horváth.R and Marek.R (2008) analyzed the importance of foreign shocks to small open economy model, in the case of Slovakia. They applied SVAR estimation building two country blocks - Slovak block and euro area block. They concluded that ECB monetary policy shock has higher effect on price level of Slovak than domestic monetary shock. Also, they noted that nearly 80% of variation in Slovak aggregate price level can be explained by external shocks in the long run and it means that domestic monetary policy shock influence price variation neatly.

Krznar and Kunovac (2010) studied the relative importance of domestic and external shocks for domestic inflation and GDP. They employed VAR model with block exogenous restriction and conclusion of their estimation states that the effect of the world price shocks to consumer prices are important. In addition, they traced out that EU GDP shocks are the key determinants of the domestic GDP fluctuations. At last, they briefly suggest that all future research on domestic inflation should take account of relevance of foreign shocks.

McCarthy (1999) studied the impact of exchange rate and import price on domestic Consumer Price Index (CPI) and Producer Price Index (PPI) in some selected industrialized countries including US, Japan and Germany. They employed VAR model in their research. They say that impulse response and variance decomposition analysis show that these external factors have modest effect on domestic price inflation. Moreover, they stated that pass-through has stronger effect on domestic price in countries with larger imports. By the way, they analyzed 6 variables VAR model including the oil price inflation, output gap, exchange rate change, import price, CPI inflation and PPI inflation.

Hahn (2003) investigated the pass-through of external shocks in euro area countries. Specially, he takes into account the oil price shocks, and non-oil import price shocks to euro area inflation

at different stages of distribution to the prices, producer prices and consumer prices. He employs VAR model in their work and he concludes that the pass through has large impact on the non-oil import price shocks. Moreover, they stated that the external shocks explain a large fraction of the variance in all price indices. They also note that the their result is robust over time and different identification schemes.

Takatoshi et al (2005) studied the similar analysis with a Hahn (2003) on the selected East Asian countries. They analyzed pass-through effect of exchange rate employing the conventional pass-through equation and VAR model. They conclude that the degree of exchange rate pass-through to import price is moderate high in the crisis hit countries while the pass-through is generally low to CPI.

2. Theoretical model – SOE

Our theoretical background is based on the New-Keynesian Small open economy model by Giordani (2004) and Svensson (2000). In these models, an economy is described simply by three equations consisting of an IS/AD curve, a Philips Curve, and a short term interest rate setting rule and a holding the uncovered interest parity is assumed. The two types of economy are modeled here by representing small open economy and rest of the world model. The small open economy equations can be augmented by exchange rate or some foreign variables while the rest of the world model is only inter dynamic of output gap, short term interest rate, and inflation. We present here small open economy model extended by Giordani (2004) in the case of Mongolia.

The small open economy

The first equation of the model is a partially forward looking pricing rule:

$$\boldsymbol{\pi_{t+1} = \alpha_{\pi} + (1-\pi)E_t\pi_{t+2} + \alpha_x x_{t+1} + \alpha_q(q_t - q_{t-1}) + \varepsilon^{cp}_{t+1}} \qquad (\mathbf{1})$$

where π_t is inflation, E_t is an expectation operator, x_t is the output gap, defined as $x_t = y_t - y_t^N$, where y_t is log real GDP and y_t^N is log real potential output; q_t is the log of real exchange rate. ε_t^{CP} is a supply shock, $\varepsilon_t^{CP} \sim nid(0, \sigma_{CP}^2)$. The coefficient are assumed to be non-negative. Potential output is modeled as an exogenous process. Here, the lags for monetary policy are brought in by $E_t\pi_{t+2}$. It is also assumed that exchange rate movements affect inflation with a lag.

The second equation of the model is IS/AD for determining the output gap:

$$\boldsymbol{x_{t+1} = \beta_x x_t + (1-\beta_x)E_t x_{t+2} - \beta_i(i_t - E_t\pi_{t+1}) + \beta_{x^*} x^*_{t+1} + \varepsilon^{AD}_{t+1}} \qquad (\mathbf{2})$$

where i_t is the instrument of monetary policy (a short term interest rate) and x_t^* denotes the foreign output gap. All coefficients are expected to be positive. ε_t^{AD} is an aggregate demand shock, $\varepsilon_t^{AD} \sim nid(0, \sigma_{CP}^2)$. Here, interest rate movements affect output with a lag.

The exchange rate follows uncovered interest parity

$$\boldsymbol{q_{t+1} - q_t = (i_t - E_t \pi_{t+1}) - (i_t^* - E_t \pi_{t+1}^*)} \quad (\mathbf{3})$$

where $\boldsymbol{\pi_t^*}$ denotes foreign inflation rate.

The last equation of the model is for setting short term interest rate. Monetary authority follows a **Taylor-type policy rule augmented by the foreign variables as follows:**

$$\boldsymbol{i_{t+1} = \rho_i i_i + (1 - \rho_i)\left(\gamma_x x_{t+1} + \gamma_\pi \hat{\pi}_{t+1} + \gamma_i i_{t+1}^* + \gamma_x x_{t+1}^* + \gamma_\pi \hat{\pi}_{t+1}^*\right) + \varepsilon_{t+1}^{MP}} \quad (\mathbf{4})$$

where ε_t^{MP} is an MP shock, $\varepsilon_t^{MP} \sim nid(0, \sigma_{MP}^2)$.

The rest of the world

The rest of the world is modeled as closed economy by the Phillips Curve, IS curve and Taylor rule.

$$\boldsymbol{\pi_{t+1}^* = \alpha_\pi^* \pi_t^* + (1 - \alpha_\pi^*) E_{t+2} \pi_{t+2}^* + \alpha_x^* x_{t+1}^* + \varepsilon_{t+1}^{CP*}} \quad (\mathbf{5})$$

$$\boldsymbol{x_{t+1}^* = \beta_x^* x_t^* + (1 - \rho_i^*)\gamma_x^* x_{t+1}^* - \beta_i^*(i_t^* - E_t \pi_{t+1}^*) + \varepsilon_{t+1}^{MP*}} \quad (\mathbf{6})$$

$$\boldsymbol{i_{t+1}^* = \rho_i^* i_t^* + (1 - \rho_i^*)(\gamma_x^* x_{t+1}^* + \gamma_\pi^* \pi_{t+1}^*) + \varepsilon_{t+1}^{MP*}} \quad (\mathbf{7})$$

where i_t^* denotes foreign monetary policy rate. It is assumed that SOE variables and shocks have no effect on ROW variables.

3. Empirical model – SVAR

3.1 VAR and model specification

We employ Vector Autoregression model by Sims (1980) in our estimation part which is considered one of the most commonly used econometric approach. The VAR model consists of a set of K time series variables $y_t = (y_{1t}, \dots, y_{Kt})$' and captures their dynamic interactions.

The basic model is designate as following form:

$$\boldsymbol{y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + u_t} \qquad (\mathbf{8})$$

where the A's are (K x K) coefficient matrices and $u_t = (u_1, \dots\dots, u_{Kt})'$ is an unobservable error term, assumed to be zero mean, independent white noise process with time- invariant, and $E(u_t u'_t) = \Sigma_u$. In other words, the u_t 's are independent stochastic vectors with $u_t \sim (0, \Sigma_u)$, p indicates the order of lag number.

First, we start with structural form of VAR model assuming the economy can be described by it, which is formed as follows:

$$\mathbf{A y_t = A_1^* y_{t-1} + \cdots + A_p^* y_{t-p} + B \varepsilon_t} \qquad (\mathbf{9})$$

where A's are the (K x K) coefficient matrices and ε_t 's are the structural innovations or shocks which is mutually uncorrelated and $var\left(\varepsilon(t)\right) = \Lambda$ and Λ indicates a diagonal matrix, where diagonal elements are the variances of structural disturbances. Here, the deterministic terms are dropped for notational convenience and no more importance of it. In other words, they are not affected by impulses hitting the system and they do not affect such impulses themselves.

In our case, we have a mission to estimate Mongolian and Chinese economic interaction using SVAR model. We have seven variable VAR model of those two countries. Mongolia as a proxy of Small Open economy has four variables which are output gap, price level, monetary policy rate and exchange rate while China as a proxy of the rest of the world economy described by 3 variables including output gap, price level and short term interest rate. If we denote Mongolian block in the model by y_1 and Chinese block by y_2, below the vector representations are presented:

$$\boldsymbol{y_1(t)' = (x_t^{MNG}, p_t^{MNG}, ir_t^{MNG}, er_t^{MNT/USD})}$$

$$\boldsymbol{y_2(t)' = (x_t^{CH}, p_t^{CH}, ir_t^{CH})}$$

We also have seven structural disturbances or shocks in line with the variables. They can be named as aggregate demand shock, supply shock, monetary policy shock and exchange rate shock respectively. If we denote the shock of Mongolian block as ε_1 and Chinese shock as ε_2, the following would be the vector representations:

$$\boldsymbol{\varepsilon_1{}' = (\varepsilon_t^{x(MNG)}, \varepsilon_t^{p(MNG)}, \varepsilon_t^{ir(MNG)}, \varepsilon_t^{er(MNG)})}$$

$$\boldsymbol{\varepsilon_2{}' = (\varepsilon_t^{x(CH)}, \varepsilon_t^{p(CH)}, \varepsilon_t^{ir(CH)})}$$

So far, we have two building blocks of two economies as represented above.

3.2 Imposing the block exogeneity restriction

If we rewrite the structural form with 2 countries block:

$$\begin{bmatrix} \mathbf{A_{11}} & \mathbf{A_{12}} \\ \mathbf{A_{21}} & \mathbf{A_{22}} \end{bmatrix} \begin{bmatrix} \boldsymbol{y_{1t}^{MNG}} \\ \boldsymbol{y_{2t}^{CH}} \end{bmatrix} = \begin{bmatrix} \boldsymbol{A_{1,11}^{*}} & \mathbf{A_{1,12}^{*}} \\ \mathbf{A_{1,21}^{*}} & \mathbf{A_{1,22}^{*}} \end{bmatrix} \begin{bmatrix} \boldsymbol{y_{1t}^{MNG}} \\ \boldsymbol{y_{2t}^{CH}} \end{bmatrix} + \cdots . + \begin{bmatrix} \mathbf{A_{p,11}^{*}} & \mathbf{A_{p,12}^{*}} \\ \mathbf{A_{p,21}^{*}} & \boldsymbol{A_{p,22}^{*}} \end{bmatrix} \begin{bmatrix} \boldsymbol{y_{1t}^{MNG}} \\ \boldsymbol{y_{2y}^{CH}} \end{bmatrix} + \begin{bmatrix} \boldsymbol{\varepsilon_{1t}^{MNG}} \\ \boldsymbol{\varepsilon_{2t}^{CH}} \end{bmatrix} \quad (\mathbf{10})$$

Since we are given that small open economy (Mongolia) shock has no significant effect on the rest of the world economy (China), we can impose the restrictions as

$$\mathbf{A_{21}} = \boldsymbol{A_{1,21}^{*}} = \cdots . = \mathbf{A_{p,21}^{*}} = \mathbf{0}$$

Such a restriction has some economic theory implication but also makes the estimation more convenient as diminishing the estimating parameters which releasing the degrees of freedom.

3.3 Identification issues

For obtaining unbiased and consistent result, we should avoid some misspecification. In the structural form, the simultaneous problem might occur which is referred that the contemporaneous correlation between the regressors and the error terms. Therefore, we should transform it to the reduced form for estimation purpose.

The reduced forms are obtained by premultipling eqs (10) with A^{-1}:

$$\boldsymbol{y_t} = \mathbf{A_1}\boldsymbol{y_{t-1}} + \cdots + \mathbf{A_p}\boldsymbol{y_{t-p}} + \boldsymbol{u_t} \qquad (\mathbf{11})$$

where $\mathbf{A_j}=\mathbf{A^{-1}}\mathbf{A_j^{*}}$ $(j = 1, \ldots . , p)$. Moreover, $\boldsymbol{u_t} = \mathbf{A^{-1}}\mathbf{B}\boldsymbol{\varepsilon_t}$ $(\mathbf{12})$, which relates the reduced-form disturbances u_t to the underlying structural shocks ε_t.

Structural shocks are linear combination of the reduced form disturbances as we see in the equation **(12)**. For simplification, if we assume that $A = I_k$ then we have $u_t = B\varepsilon_t$. B is not observable at all, so if B is not diagonal, the innovations u_t will be correlated with each other. It will now allow us to pick out shock of a particular variable. Therefore, to ensure the orthogonality of the innovations in the model with K variables, at least $k(k-1)/2$ restriction should be imposed. In our case we impose 21 restrictions. One possible way to do is to employ Choleski decomposition method. So, we have restricted B to be lower triangular. Our recursive identification scheme therefore as below:

$$\begin{pmatrix} u_t^1 \\ u_t^2 \\ u_t^3 \\ u_t^4 \\ u_t^5 \\ u_t^6 \\ u_t^7 \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ d_{21} & 1 & 0 & 0 & 0 & 0 & 0 \\ d_{31} & d_{32} & 1 & 0 & 0 & 0 & 0 \\ d_{41} & d_{42} & d_{43} & 1 & 0 & 0 & 0 \\ d_{51} & d_{52} & d_{53} & d_{54} & 1 & 0 & 0 \\ d_{61} & d_{62} & d_{63} & d_{64} & d_{65} & 1 & 0 \\ d_{71} & d_{72} & d_{73} & d_{74} & d_{75} & d_{76} & 1 \end{pmatrix} \begin{pmatrix} \varepsilon_t^{x(ch)} \\ \varepsilon_t^{p(ch)} \\ \varepsilon_t^{ir(ch)} \\ \varepsilon_t^{x(mng)} \\ \varepsilon_t^{p(mng)} \\ \varepsilon_t^{er(mng)} \\ \varepsilon_t^{ir(mng)} \end{pmatrix}$$

Determining the reasonable ordering of the endogenous variables is particularly important for identifying the structural shocks. First of all, we start the ordering with Chinese variables relaxing the block exogeneity restriction and variables of Mongolian block are placed afterwards. We followed the ordering logic based on the macroeconomic theory where the most variables are ordered as follows: GDP, price, interest rate, other variables (exchange rate). Therefore, we order the variables in the sequence of output gap, price level, exchange rate and policy rate. We change the order of the exchange rate and the policy rate as if the monetary policy rate is affected contemporaneously by the all variables.

Actually, we reorder the variables in the robustness check part, but we found no significant difference which indicates that the model is robust.

3.4 Data description and initial analysis

The data we utilized in our research work consists of seven time series of the two countries, Mongolia and China. We have monthly data ranges from 1998:M3 to 2011:M12, totally 166 observations.

The data of Mongolia consists of real GDP, consumer price index (CPI), monetary policy rate, and exchange rate. The real GDP and CPI are calculated on the base year 2005. Since the real GDP is not available by monthly frequency, we interpolated it using the cubic spline method. It is log-linearized and seasonally adjusted. We used output gap for representing economic cycle and it is obtained from the Hodrick-Prescott filter. CPI is used for price level and it is in the log form. 7-day central bank bill rate is utilized as monetary policy rate of Bank of Mongolia (BOM). Exchange rate expresses the rate of the Tugrug (Mongolian National currency) against the US dollar. It is also in log-linearized level. Data is taken from the publicly available sources such as Bank of Mongolia and National Statistical Office of Mongolia (NSO).

Chinese dataset is comprised of real GDP,CPI, and short term interest rate. Real GDP and CPI are calculated using 2005 as the base year which is the same as the data of Mongolia. Short term interest rate refers repurchase rate on Interbank market for Treasury Bonds with a 3 month maturity. We estimated the series of consumer price index in the log-linearized form and the Hodrick-Prescott filter is used to obtain output gap of China, too. We take the data from the OECD database.

3.5 Initial analysis

First of all, we run some initial tests for the data properties such as stationary and cointegration. We applied several tests for the stationarity including Augmented Dickey- Fuller (ADF), KPSS and Schmidt Phillips test. Below we summarized the ADF and KPSS test result.

Table 1 ADF and KPSS test in log level and log differences

	ADF test statistic	**Optimal lag length (SC)**	**KPSS test statistic**
Variables of Mongolia			
$\boldsymbol{cpi\_mn\_l}$	**2.5838**	1	**5.4477*** **
Δcpi_mn_l	-6.3842 ***	0	0.0810
$\boldsymbol{ir\_mn}$	**-1.6238***	0	**1.2914*** **
Δir_mn	-0.7970	0	1.0038***
$\boldsymbol{ex\_mn\_l}$	**1.4402**	1	**3.9231*** **
Δer_mn_l	-6.3001***	0	0.1634
$\boldsymbol{gap\_mn}$	**-2.8699*** **	10	**0.0577**
Variables of China			
$\boldsymbol{cpi\_ch\_l}$	**2.4457**	1	**5.1440*** **
Δcpi_ch_l	-7.1735 ***	0	0.4457
$\boldsymbol{ir\_ch}$	**-1.5060**	0	**0.4995***
Δir_ch_l	-1.0503	0	0.4147
$\boldsymbol{gap\_ch}$	**-1.6151***	10	**0.1377**

*Note: H_0 of ADF test assumes the series is unit root (stationary) whereas H_0 of KPSS test assumes times series is stationary. * denotes the significance level. (*, **, *** - 90%, 95%, 99% respectively).*

The ADF test is performed up to 10 lags without constant and trend. All the variables except the output gap of both countries and the short term interest rate of Mongolia are not stationary in the *log level*. The KPSS test shows the controversial results on the interest rates as if the Mongolian

policy rate is nonstationary while the interest rate of China is stationary. Otherwise, the test results were the same as the ADF test. Next, we take the first differences and run the above tests for the unit root. ADF test result shows that both countries interest rates are nonstationary in the level while all the variables become stationary in the first difference. The KPSS test indicates that all the variables except policy rate of Mongolia are stationary in the first difference. Since the VAR system stability matters rather than whether the individual times series contain a unit root. This discussed below specifically on the following pages.

Next approach to the estimation is the lag selection. We performed several tests for the number of optimal lag length selection once it is considered as an important step in the VAR modeling. The tests we applied here are Akaike information criterion (AIC), Schwarz information criterion (SC), Hannan-Quinn information criterion (HQ), Final Prediction Error (FPE). Briefly, AIC test suggests 10 lags whereas the SC stands for 4 lags. Actually we tried till VAR (10), with or without trend, constant and seasonal dummies. But those two test result stayed unchanged. Since we have short samples, usually the SC result is preferable. So, we are faced with VAR(4) which seems high for the small number of data we try other approaches to lag selection. Due to the short sample data, some formal criterion suggested lag length can be ignored. By the way, the most related works choose lag length 1, 2 or 3 for such a short sample. So, we chose lag length as $p=2$. We test the VAR (2) model by CUSUM for the stability of the model. It passed the test. Moreover, we checked the autocorrelation and crosscorrelation of residual visually and the result was also considerable. Therefore, VAR (2) will be utilized on the further estimation. It is proper to mention that we also tried VAR (4) in the estimation. Surprisingly, it demonstrates the similar

result with VAR (2) except monetary policy shock response[2]. Also, exchange rate response was more significant.

Next preliminary test stands for cointegration and we check the cointegration among the variables in the VAR (2) model by Johansen Trace Test. The test result is shown below. We can say that there are 4 cointegrated vectors in the model at the 99% significance level.

Table 2 Cointegreation test result

r 0	*LR*	*p value*	*99%*
0	317.4	0.0000	144.91
1	205.81	0.0000	112.88
2	116.58	0.0000	84.84
3	70.89	0.0006	60.81
4	45.26	0.0024	40.78
5	26.73	0.0045	24.69
6	12.45	0.0104	12.53

So far, we have nonstationary time series in the log level and cointegrated vectors from the preliminary test result. Seeing that, now we can either choose VECM or VAR with the level. Since some literature (Sims et al. (1990)) say that it is proper to estimate VAR system in the level because sometimes it is difficult to determine cointegration relation in small sample. Specially, Sims et al. (1990) also argued that it is usually unnecessary transforming the models to the stationary form by differencing or cointegration operator whenever it appears. Therefore, we estimate the VAR system in the level. Some literature[3] say that including deterministic terms maybe required for a proper representation of data generating process. Concerning this advice,

[2] See the result on the appendix 2
[3] Especially, the book "Applied Times Series Econometrics" by Helmut Lutkepohl

we also add intercept and time trend. By the way, we also should admit that including those deterministic terms allow us to obtain smooth and reasonable impulse response. Although, we also estimate the model without intercept and trend but the remarks of responses stayed unchanged. At the end, the impulse responses are conducted by 95% confidence level, which were bootstrapped using 100 replications suggested by the software. In the next section we present the empirical results.

4. Empirical Results

In this section we introduce our estimation result. We utilized impulse response function and forecast error variance decomposition as our estimation tools. Impulse response captures dynamic response of the variable to an innovation in the structural equation while the forecast error variance decomposition (FEVD) shows the variability of particular variables due to its own or other variables shock. In the other words, we will be able to differentiate the contributors of the variability of a particular variable. First, we analyze the response of domestic price level to the domestic shocks. Thereby, we recognize which domestic shock significantly affects on the price level. Next, we take into account the external shocks. It explores the domestic price level response to the external shocks. As we already know from the model specification part, the China is imposed to the external shock source.

4.1 Response of the price level to the domestic shock

Figure 1 The effect of aggregate demand shock to the price level

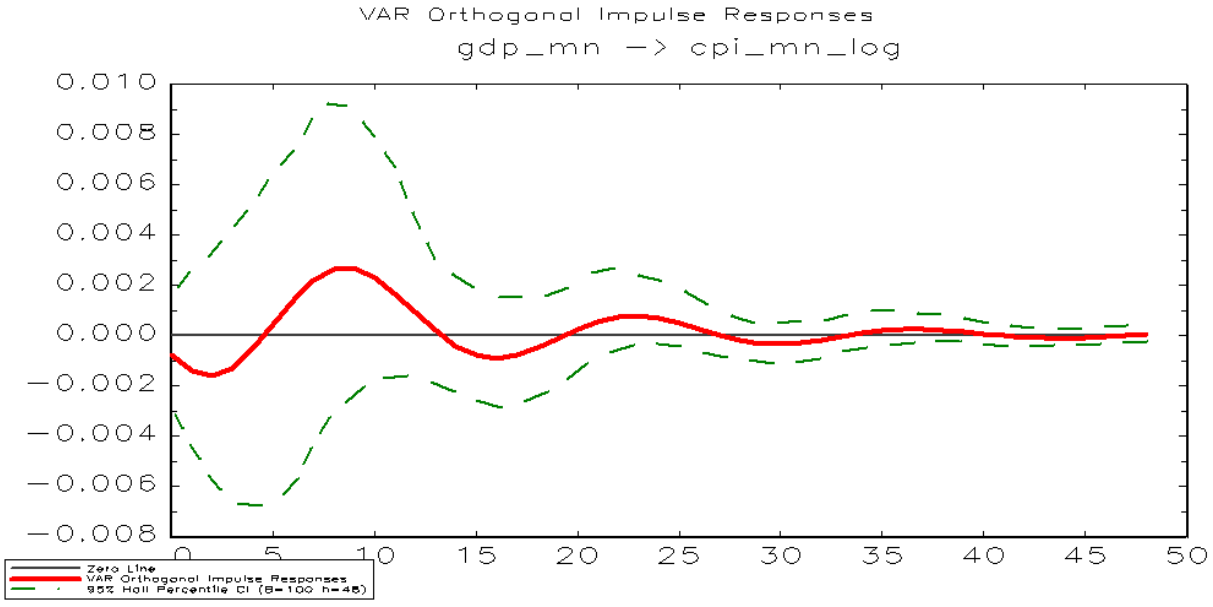
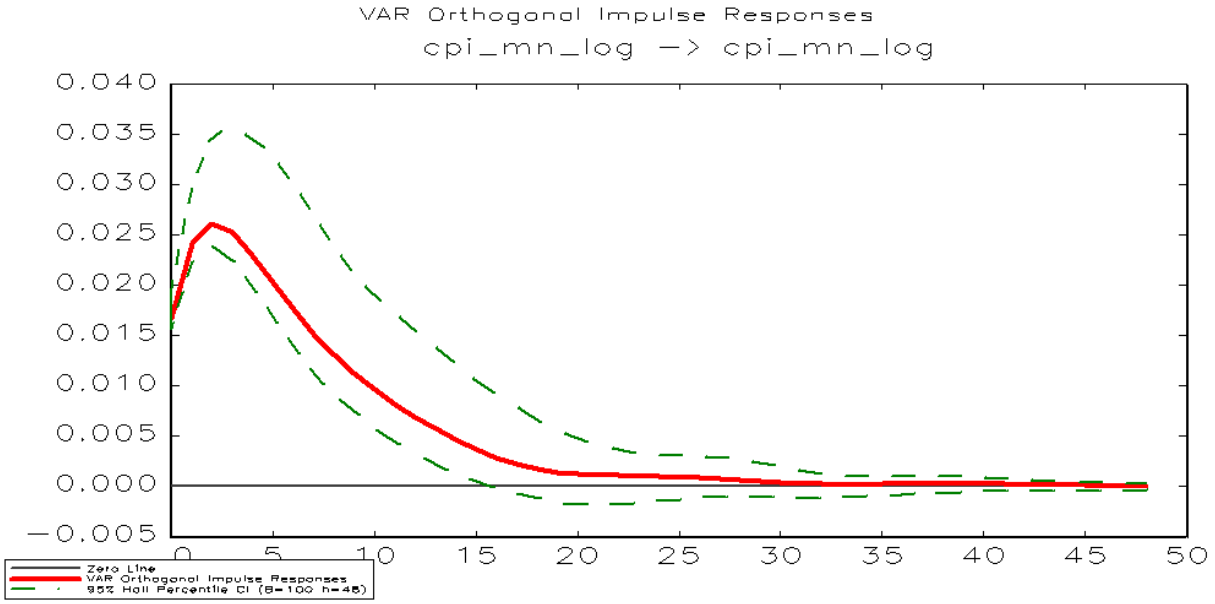


Figure 1 reports how aggregate demand shock affects the price level. After a positive aggregate demand shock, price slightly drops after 2 months. Nonetheless, it starts increasing gradually and attains its peak (0.27%) after 9 months. The price response to the demand shock seems more like a roller coaster but the fluctuations dissipate by the time. The shock is not significant in the long run. The result of the impulse response is in line with a theory which states inflation raises as aggregate demand increases if only we do not take into account the swift drop in the price level after 2 months.

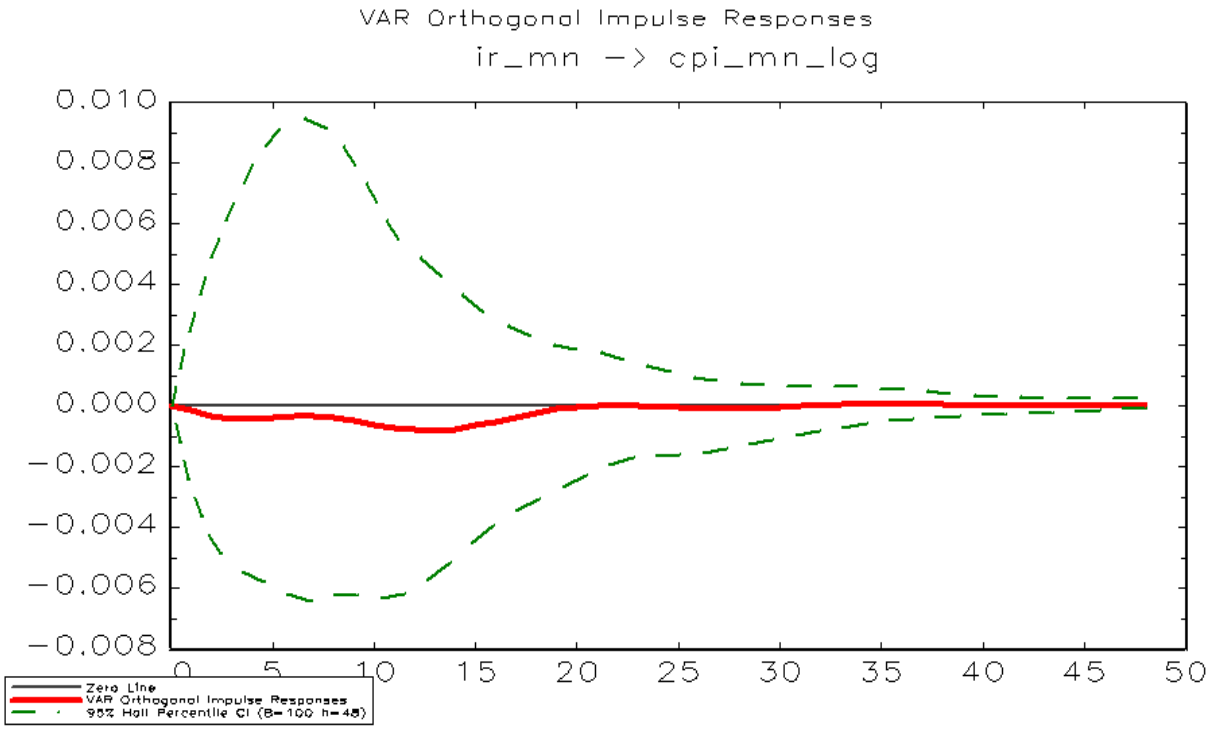
Figure 2 The effect of supply shock to the price level



Here, we can see the impact of positive supply shock of one standard deviation on the price level. As we can see on the impulse response graph, price level immediately responds to the shock. After 2 months, the price response reaches the maximum level (2.61%) and start declining gradually. But positive supply shock affect lasts significantly for 13 months on the price level and becomes insignificant after 21 months. We can say that inflation is not that persistent to the shock. The result is in line with what we would expect from the economic theory. Notably, the

supply shock has very strong influence on the price. A petrol and meat price often and sudden increase perhaps could be the reasonable explanation of it.

Figure 3 The effect of monetary policy shock to the price level



Price level declines in accordance with positive monetary policy shock. The result of the impulse response is in line with what we expect from economic theory. The price level declines gradually after the shock occurs. The shock impact shows its maximum effect after on the price after 13 months as the price decreasing by 0.08%. We would say that monetary policy shock has relatively weak impact on the price level.

Figure 4 The effect of exchange rate shock to the price level

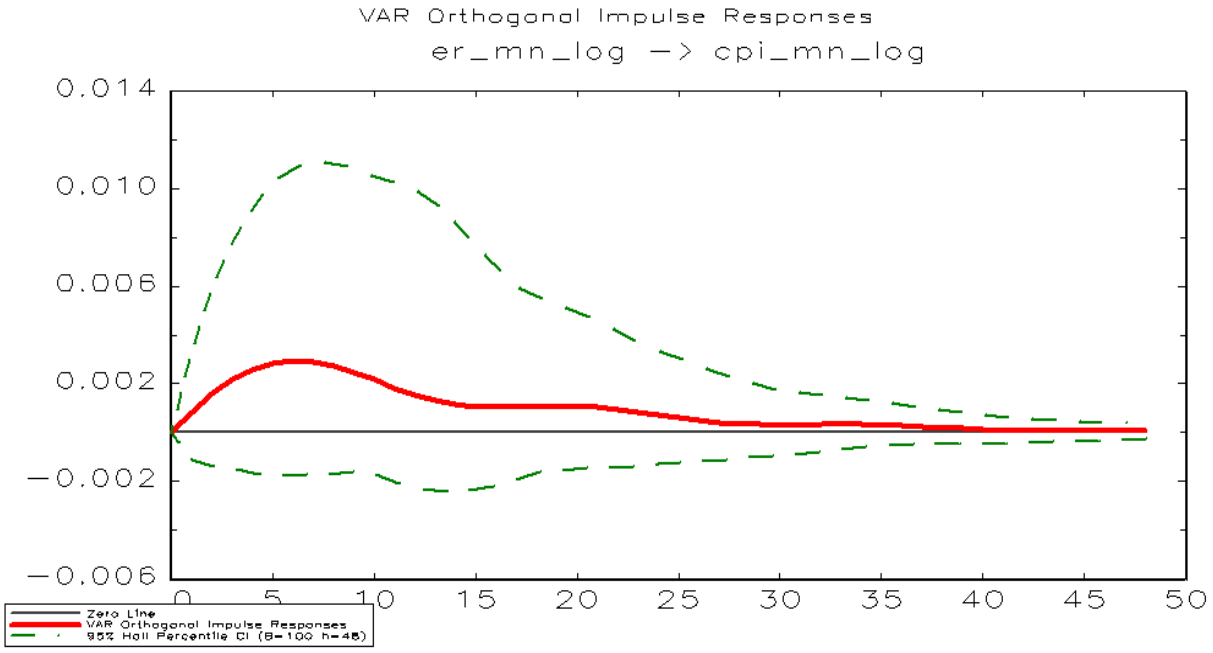


Figure 4 shows the result of the price response to the nominal exchange rate shock. Its impact lasts for 2years on the price level and vanishes. The price increases gradually after the shock and the price reaches its peak (0.3%) after 6 months. The price stayed high for 3 months and starts decline. In addition, our result is in line with result of Gan-Ochir.D et al (2002), who find that the price level peaks after 6 months in response of the exchange rate shock[4].

To sum up, we can say that aggregate demand and supply shocks influence more significantly on the price to compare with policy rate shock. This general result complies with the work of (Batsukh.Ts, 2007) which concludes that inflation is more likely to be explained by the supply and demand factors. Although, the exchange rate shock also influences on the price level moderately as it has stronger impact on the price in comparison with the monetary policy shock. This result also fits with the research of Batnyam et al (2007).

[4] Estimation with VAR(4), exchange rate is more significant. See on Appendix 2

4.2 Response of the price level to the external shocks

Figure 5 The effect of external aggregate demand shock to the price level

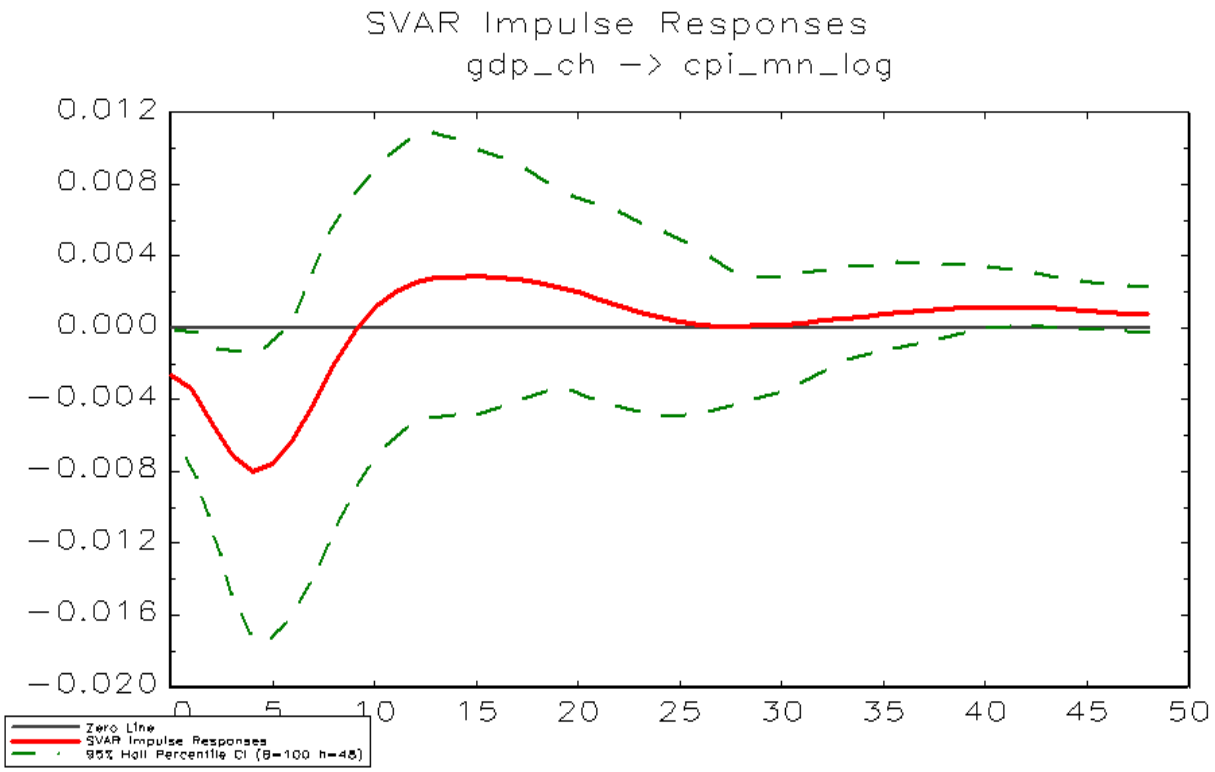
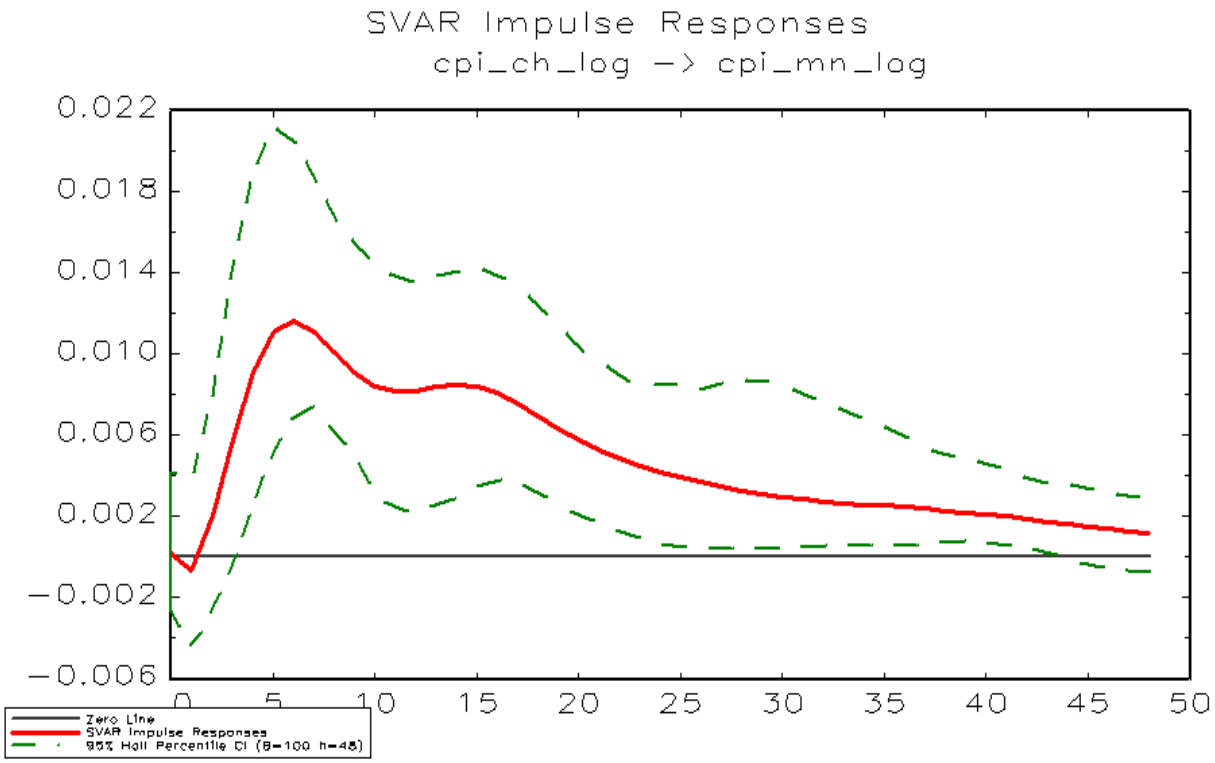


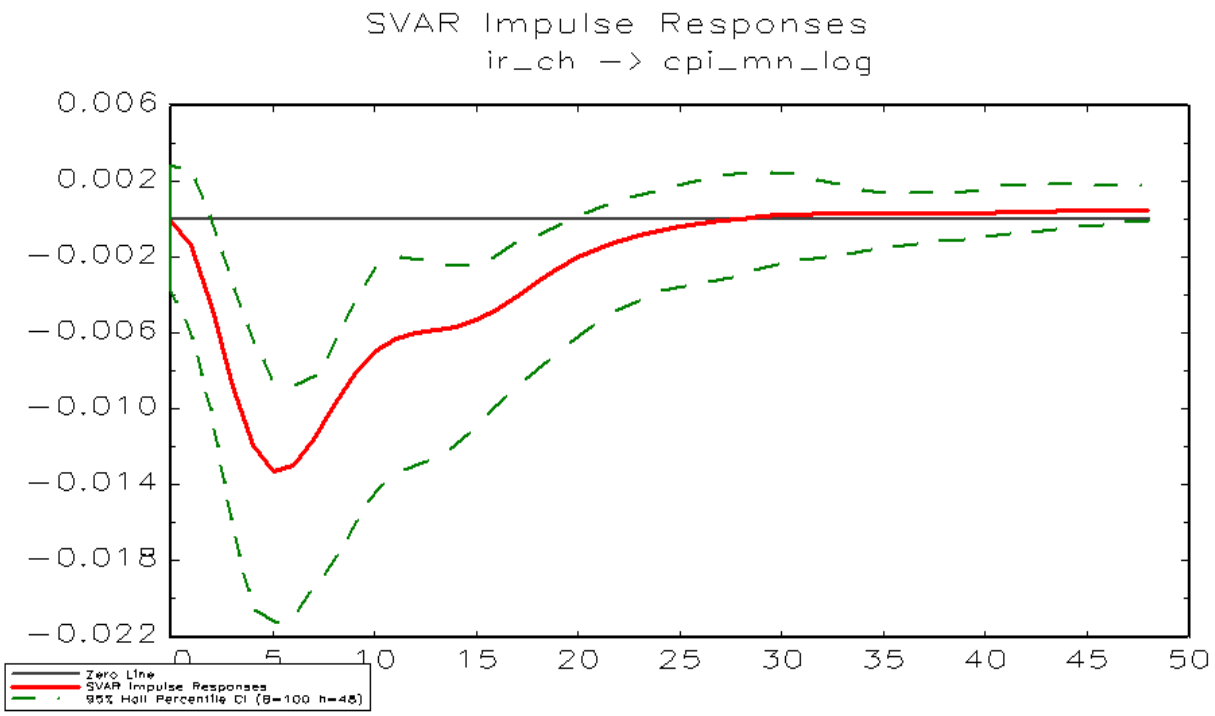
Figure 5 presents the external demand shock to the domestic price level. Positive demand shock of one standard deviation stimulates the domestic price level to decrease gradually in 5 months horizon. It reaches its bottom point (-0.76%) after 5 months. Nonetheless, it increases again and attains its peak (0.28%) after 13 months. The demand shock dissipates after 22 months. In the long run the demand shock has no significant effect on the domestic price level.

Figure 6 The effect of external supply shock to the price level



As we can see on the impulse response graph, the positive supply shock of one standard deviation stimulates the price to increase gradually. It reaches its peak (1.16%) after 6 months. The impact of the shock reduces the price gradually from the 8th month and even though the shock still holds its effect in the long run even it is small. Therefore, we can say that the external supply shock plays in a pivotal role in the domestic price level.

Figure 7 The effect of monetary policy shock to the domestic inflation



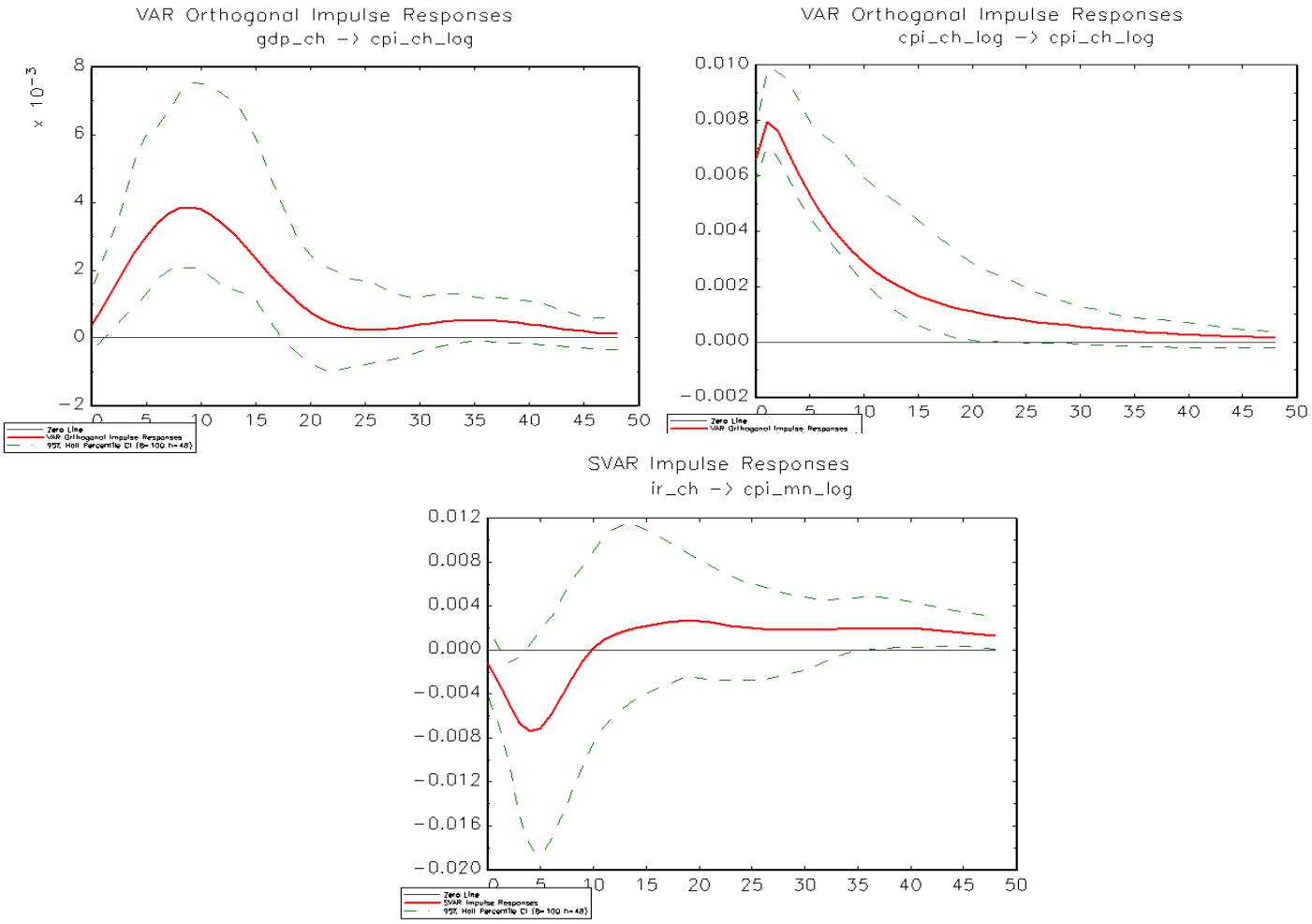
In the figure 7, we are given positive monetary policy shock to the domestic price level. As we can be seen on the impulse response, the domestic price decreases gradually and reaches the bottom (1.33%) after 5 months. The price level starts increasing from the 6th month and this raise continues until 28th month. The shock impact becomes insignificant after 29 months later. As we can see the external monetary policy shock has very big impact on the domestic price level even much stronger than domestic monetary policy.

To sum up, we can conclude that every external shock has significant effect on the domestic price level. It is even much more influential than the domestic shocks at all. Moreover, it says that Mongolian economy (price level) highly depends on China economic activities.

4.3 Foreign price level response to its own shock

In this part, we take into account the foreign price level response to its own shocks to take quick familiarization.

Figure 8 Foreign price level response to its own shocks



Overall, all the impulse responses are in line with economic theory except the monetary policy shock. The price responds swiftly to the supply shock as increasing by 0.7% after two months. Moreover, the price starts declining eventually from the 3rd month. The shock keeps its significance on the price for 36 months and its significance level becomes unnoticeable. Monetary policy tightening somehow increases the price level. After the shock, the price

increases gradually and reaches its peak (0.32%) after 7 months. Furthermore, after showing the maximum response to the shock, it declines smoothly. The policy shock keeps its effect in the long run as well even it is not that significant on the price level. The aggregate demand shock impulse response result is in line with one we would expect from the economic theory. After the demand shock, the price level crawls up. It attains its peak (0.38%) after 9 months and decreasing gradually. The effect of demand shock almost lasts for 2 years. In addition, price react to the shock becomes almost insignificant in the long run.

4.4 Variance decomposition analysis

In this part we present the result of forecast error variance decomposition (FEVD) analysis from our SVAR model. We stress here the importance of the domestic and foreign shock to the domestic variable variability. Moreover, we will be able to recognize the contribution of each shock in the system to a particular variable variance. We present here the variance decomposition of domestic price, interest rate, exchange rate and output gap.

Table 3 Variance decomposition of Price

Forecasted horizon	***External shocks***	***Domestic shocks***	***cpi_ch***	***ir_ch***	***cpi_mn***	***ir_mn***	***er_mn***
1	0.04	0.96	0	0	0.72	0.01	0.22
6	0.55	0.45	0.15	0.26	0.24	0.08	0.12
12	0.71	0.29	0.28	0.33	0.14	0.06	0.08
24	0.77	0.23	0.37	0.31	0.11	0.05	0.06
36	0.78	0.22	0.39	0.3	0.1	0.05	0.06

We are mostly very curios on the variance decomposition of price level. As we can see in the table 3, the price level variability mostly attributable to the domestic shocks where its own supply shock is dominant accounting over 72% and exchange rate shock also significantly contributes to the price level variability in one month horizon. If we see what happens after 6 months horizon, the external shock becomes dominant in the domestic price variability. In the long run, as assessed by 3 years horizon, the external shocks account nearly 78% in domestic price level variability while the domestic supply, exchange rate, stayed as contributing only 10%.

Table 4 Variance decomposition of Interest rate

Forecast horizon	***External shock***	***Domestic shock***	***cpi_ch***	***ir_ch***	***cpi_mn***	***ir_mn***	***er_mn***
1	0.04	0.95	0.02	0.01	0.06	0.6	0.04
6	0.11	0.89	0.04	0.05	0.03	0.64	0.02
12	0.26	0.74	0.19	0.04	0.02	0.53	0.03
24	0.44	0.56	0.29	0.04	0.02	0.4	0.02
36	0.45	0.55	0.29	0.05	0.02	0.39	0.02

Table 4 reports the variables contributions to the interest rate variability. In 6 months horizon, the domestic shocks mostly dominate to the variance of the domestic interest rate. Precisely, its forecast errors are largely attributable to its own innovation, accounting 60% of the shock. In the long run, the external shocks also play pivotal role as composing nearly 40% of variability. In addition, the interest rate is not largely affected by the external shocks in the long run to compare with price variability.

Table 5 Variance decomposition of Exchange rate

Forecast horizon	*external*	*internal*	*cpi_ch*	*ir_ch*	*gap_ch*	*ir_mn*	*er_mn*
1	0.77	0.24	0.01	0.63	0.13	0.06	0.17
6	0.84	0.16	0.08	0.53	0.23	0.04	0.11
12	0.86	0.13	0.11	0.39	0.36	0.05	0.08
24	0.86	0.14	0.11	0.4	0.35	0.05	0.08
36	0.86	0.14	0.11	0.4	0.35	0.05	0.08

Table 5 presents the result on the variance decomposition for exchange rate. We find that almost all of the variance in the exchange rate is explained by external shocks both in the short and long run. Notably, China monetary and demand shock play in a main role of the fluctuation of exchange rate of Mongolia.

Table 6 Variance composition of Output gap:

Forecast horizon	*External shock*	*Domestic shock*	*cpi_ch*	*ir_ch*	*cpi_mn*	*ir_mn*	*gdp_mn*
1	0.01	0.99	0	0	0.07	0.14	0.77
6	0.05	0.95	0	0.01	0.03	0.12	0.79
12	0.26	0.73	0.04	0.02	0.03	0.15	0.54
24	0.31	0.69	0.05	0.03	0.03	0.15	0.54
36	0.31	0.68	0.05	0.03	0.03	0.15	0.49

Next, Table 6 shows the result of variance decomposition for Mongolian output gap. We can say that the variability in output gap can be explained by the domestic shocks both in the short and

long run. The main contribution to the variability comes from the domestic demand shock as accounting the 79% in 6 months horizon. By the consideration, the domestic monetary policy shock is also attributable while the supply shock influence is relatively small. But we never can underestimate the external shock which still accounting 31% of the fluctuation.

4.5 Robustness check

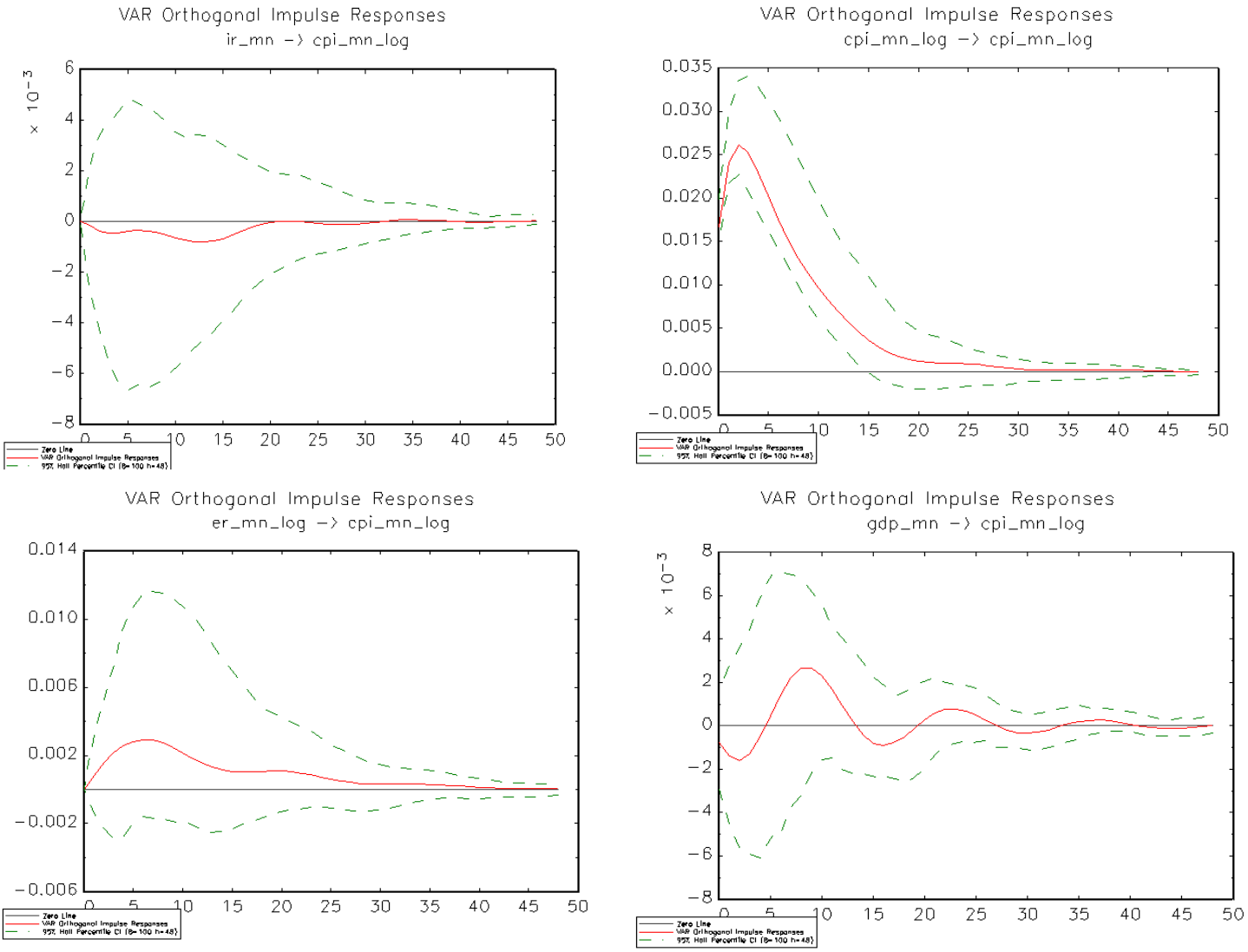
In this part we investigate the robustness of the model. In doing so, we utilize two approaches for the investigation of the robustness. First, we changes the ordering of the variables in the model to see whether the impulse response changes. Second, we changed sample time period to check how robustness the model is over time.

4.5.1 Different identification schemes

We check the model robustness using two different identification schemes. First, we make some slight difference on the ordering by changing the exchange rate and monetary policy rate order.

In our main text, we order the variables as following sequences: aggregate demand shock, supply shock, policy shock in Chinese block whereas in Mongolian block of variables are ordered as demand shock, supply shock, exchange rate shock and policy shock. Now, we change the order of exchange rate and monetary policy rate as in the work of Mojon and Peersman (2001) which are placed as follows: demand shock (ch); supply shock (ch); policy shock (ch) ; demand shock (mn); supply shock (mn); monetary shock (mn); exchange rate shock (mn). Below, the result of the impulse response is presented.

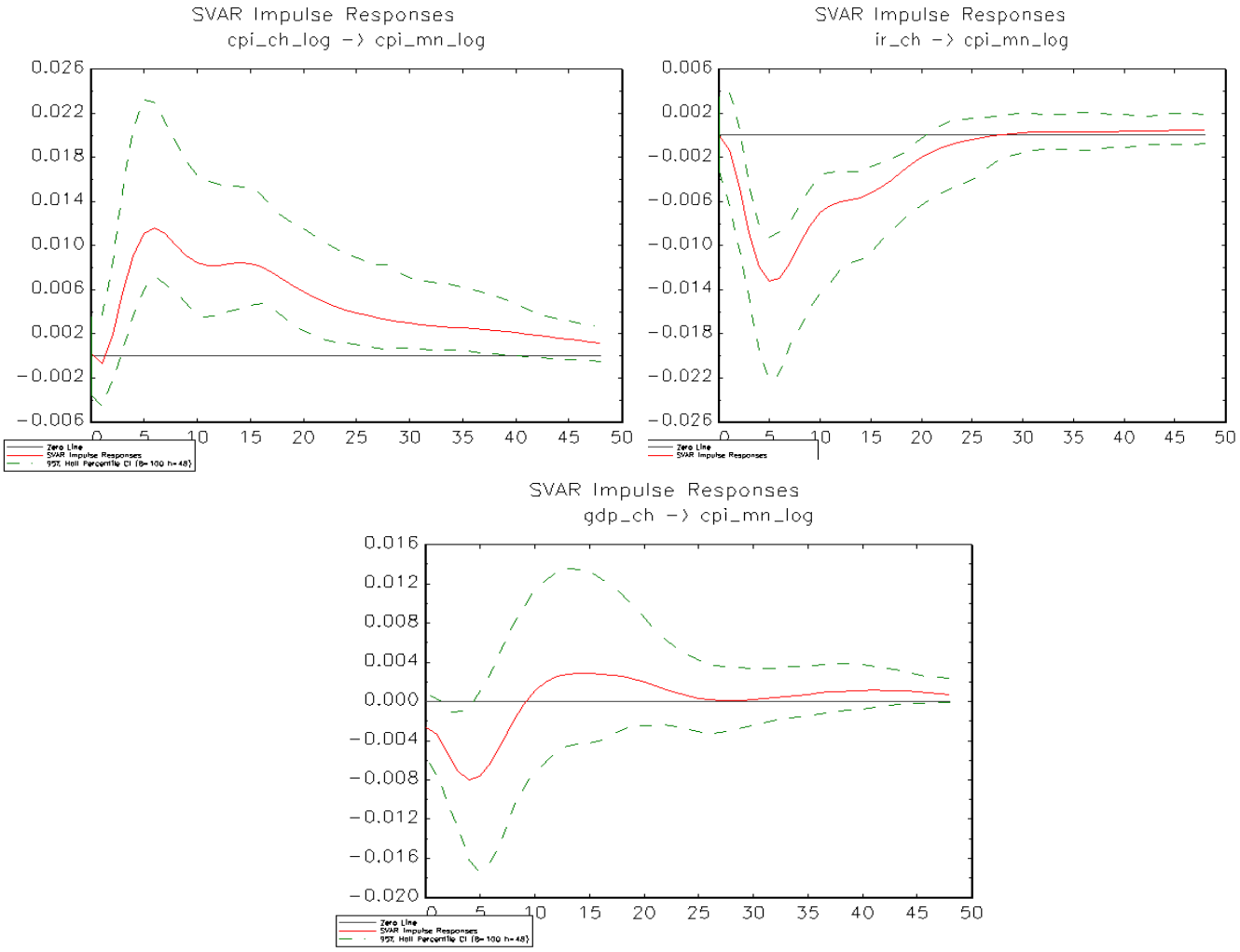
Figure 9 Robustness check 1: The domestic price response to the domestic shocks



Surprisingly, the supply shock effect is exactly the same with original model indicating the same price response. It is good sign of the model robustness. Furthermore, we take into account the exchange rate shock, it also react the same as original model. Again the shock vanishing horizon of the price is the same. Response of the price to the demand shock is also the same as baseline specification model if only ignoring slight differences. Therefore, we ascertain that the domestic

model explaining the price level is robust as if we change the order of the original model, the result remain the same.

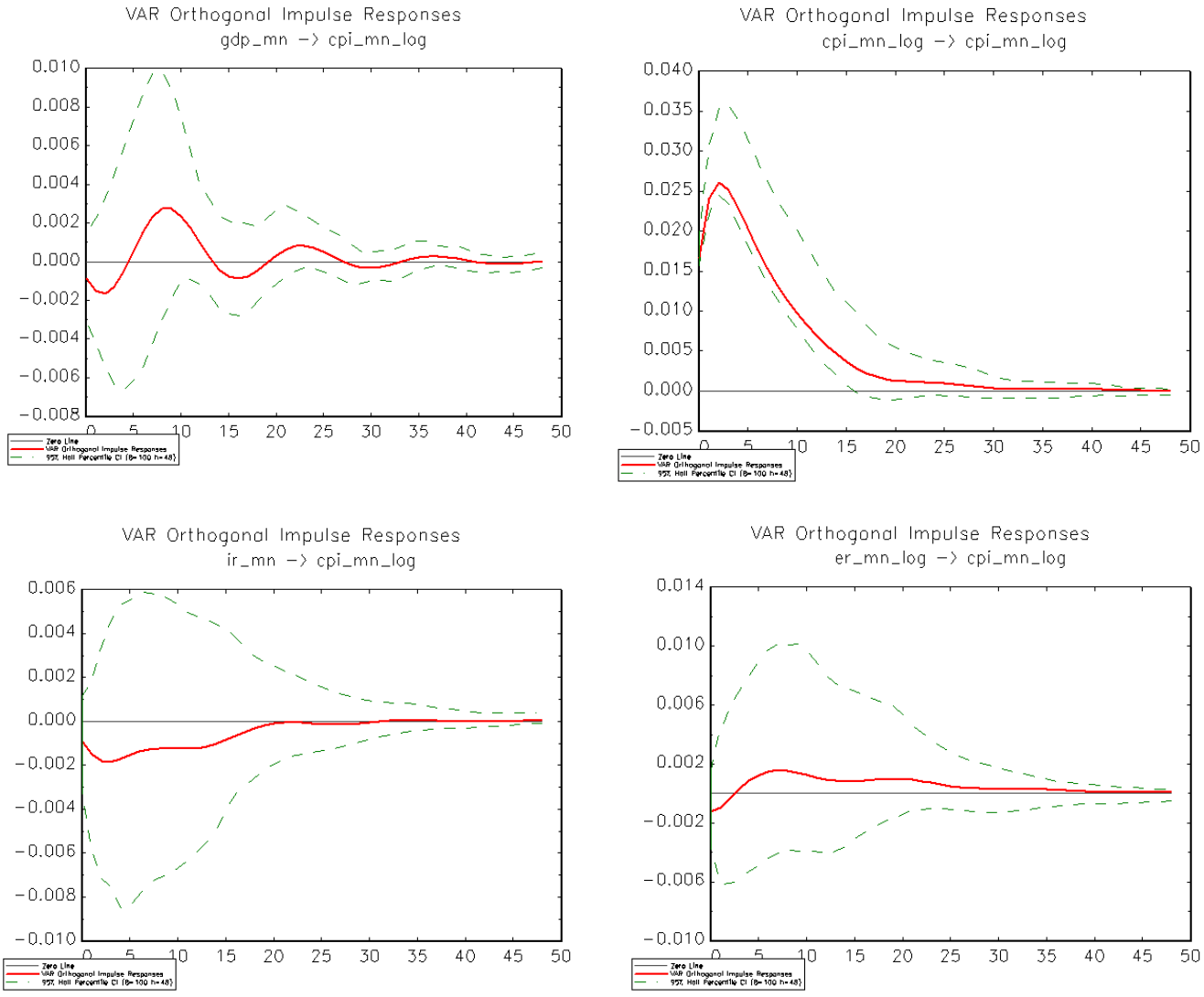
Figure 10 Robustness check 1: The domestic price response to the external shocks



External shock effect on the domestic price level demonstrates the proper indication with the original model.

In the next place, we change the order of the variables as follows, similar with the work of Hahn(2003): policy rate (ch), exchange rate (ch), output gap (ch), interest rate (mn), exchange rate (mn), output gap (mn), price (mn). Below the results are shown:

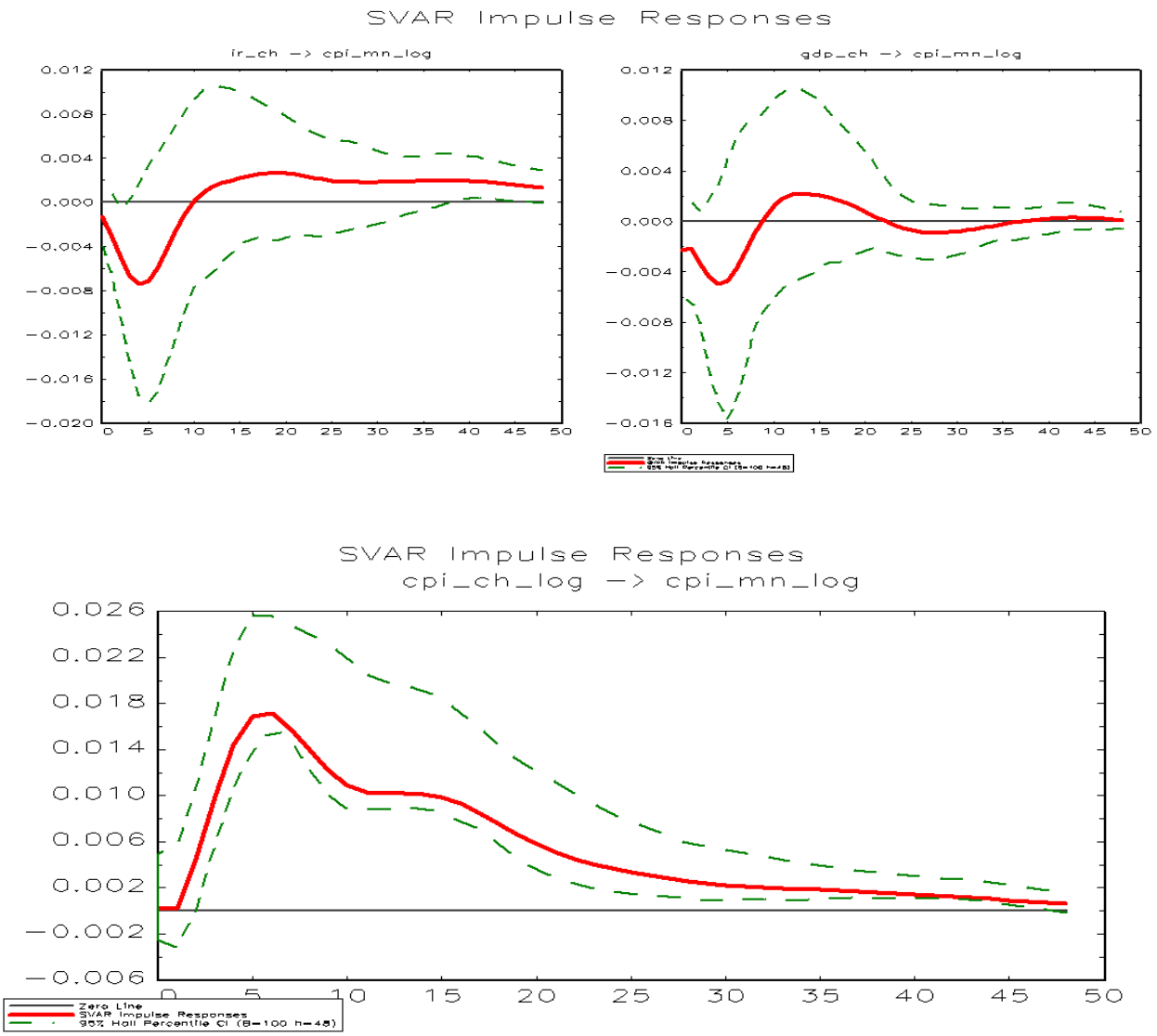
Figure 11 Robustness check 2.1: Domestic price response to the domestic shocks



Overall, the aggregate demand and supply shock do not differ from the original model impulse response. The interest rate response to the monetary policy shock differs slightly from the main model. The price attained its peak after 13 months later in the original model while here it

reaches its peak after 3 months. Furthermore, the exchange rate shock has rather less impact on the price level to compare with the baseline specification. The two approaches to detect the robustness of the model gives us good result which indicates that our model is not sensitive to the different identification schemes. In the next subsection, we check the model robustness over time.

Figure 12 Robustness check 2.2: Domestic price response to the external shocks

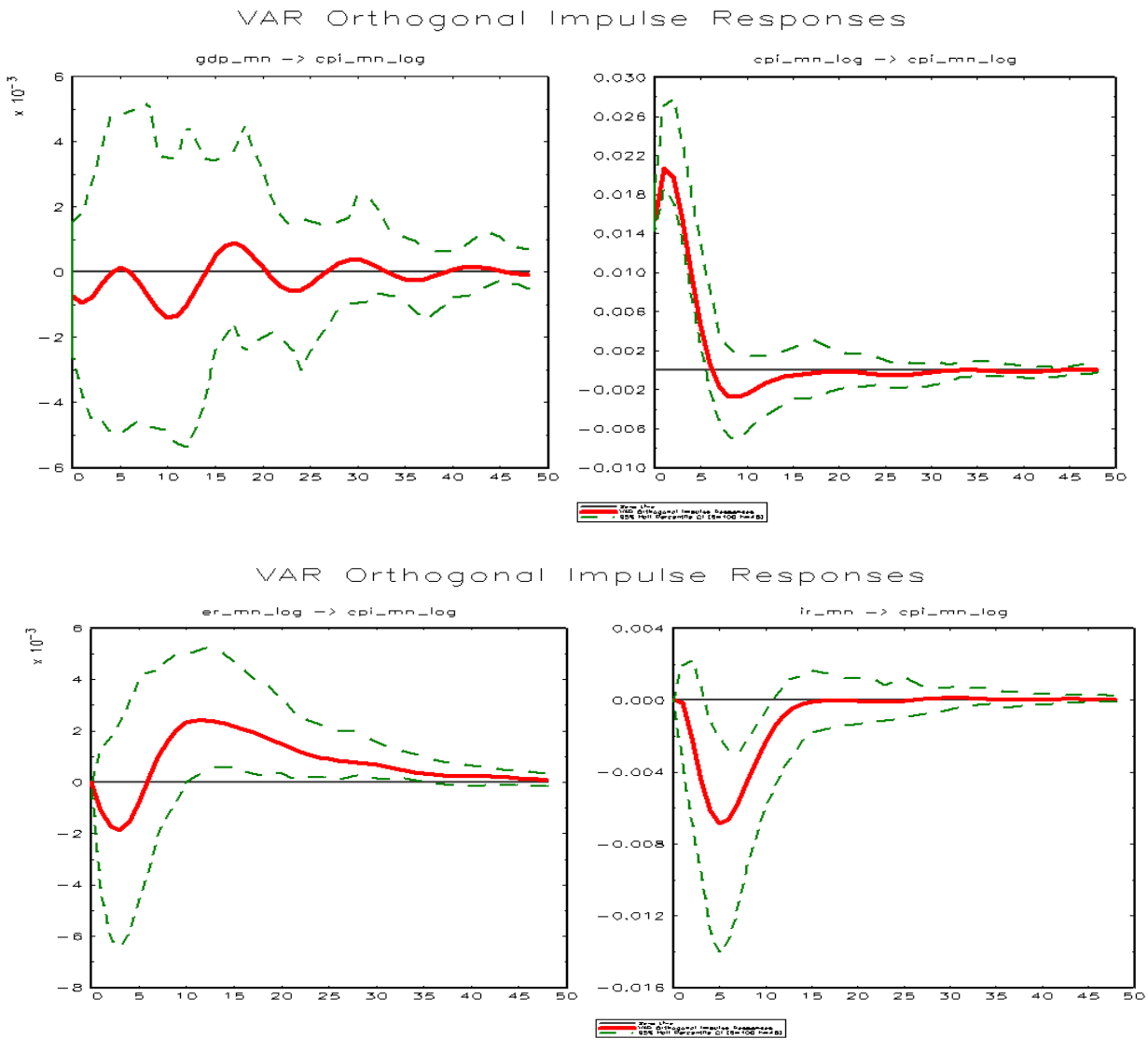


For foreign shock, the result is the same as in the original model.

4.5.2 Model robustness over time

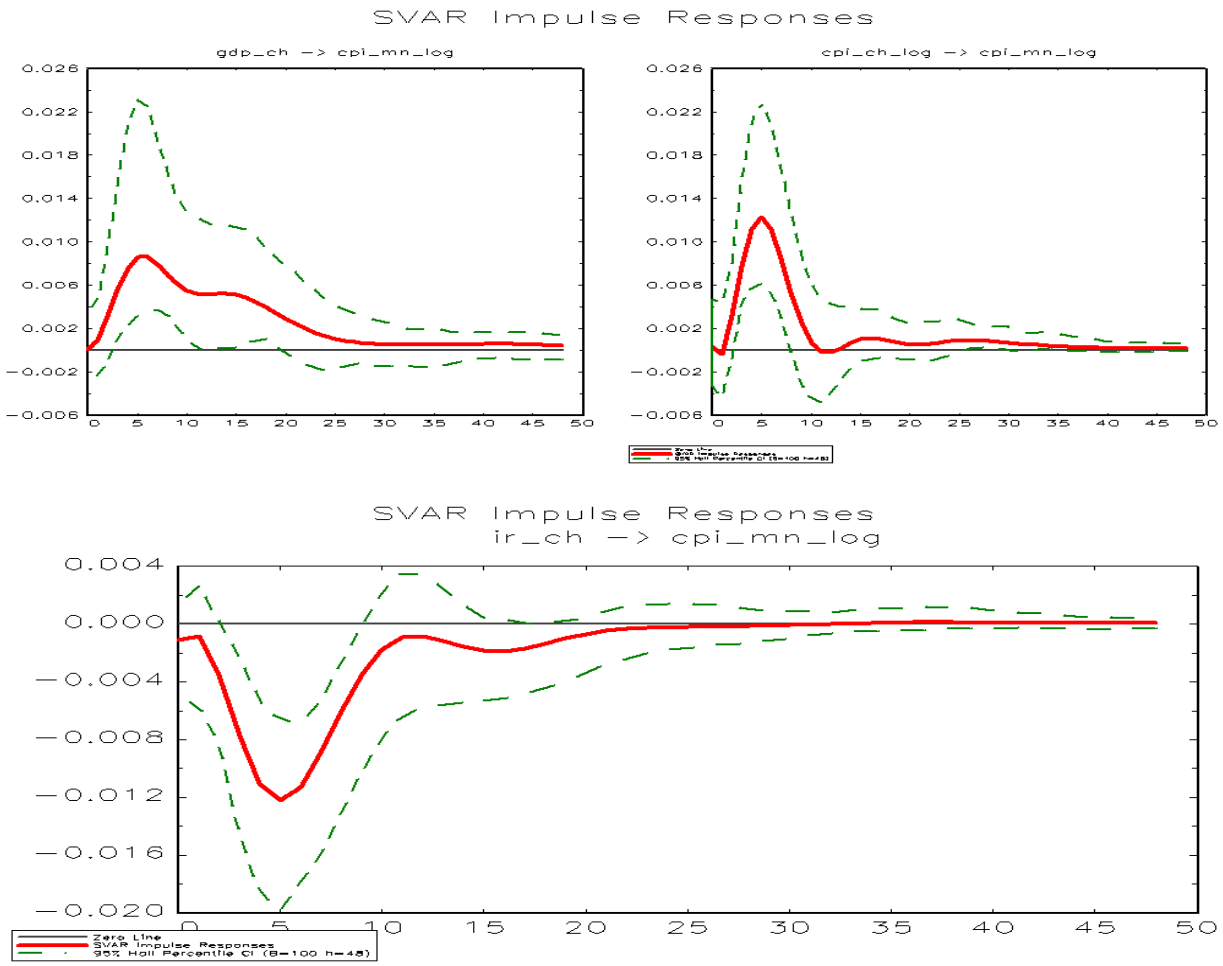
We estimate the original model with the data spans from 1998:M3 to 2011:M12. To check the robustness of the model over time, we modified the data from the 1998:M3 to 2007:M12 considering the global financial crisis. Now, our sample period is short and it may influence on the impulse responses.

Figure 13 Robustness check 3.1: Domestic price level response to the domestic shocks



The result differs more or less from the baseline model. The general feature which we can observe on every impulse response is shock enduring period. Now, in simulation model, shock effect quickly vanishes while in the baseline model the shock effect lasts longer. It perhaps relates to the sample period shortage. Moreover, one reasonable explanation can be the structural breaks from the financial crisis.

Figure 14 Robustness check 3.2: The external shock to the domestic price level



Basically, the external demand shock to the price level differs slightly in the simulation model. Although, the supply shock effect demonstrates the similar response besides the shock vanishing over time as in the domestic response. The demand shock affect to the price changed as if there

is no price decline in first months as in the original model. Furthermore, the monetary policy shock seems similar with the baseline specification.

We checked the model robustness in this part. First, we change the order of the variables in two ways. Both of them give as the same result as the original model. Second, we change the sample period of the original data and obtain slightly different results. This slight difference can be explained by the structural breaks stemmed from the financial crisis (2007-2010) and relatively short sample. Therefore, we conclude the model is robust.

5. Conclusion

In this thesis, we aimed to define the main causes of inflation in Mongolia. By doing so, we utilize a small open economy VAR model for Mongolian economy and assessed the domestic and foreign shocks affect to the price level. We choose China as a proxy of foreign shock source.

First, we assess an effect of the domestic shocks to the price level of Mongolia. We find that the supply shock plays in a main role in the price level. The price responds to the shock increasing by 2.61% after two months and the shock affect is significant for 13 months. In addition, the demand shock is also considerable as after the shock occurs the price level slightly drops but starts increasing by 0.27% after 8 months. Monetary policy shock rather less significant on the price level. After one standard deviation of monetary policy shock, the price level decrease by 0.08% at most after 13 months while exchange rate shock stimulates the price to increase by 0.3% after 6 months. We also found that the domestic shocks do not last longer which is significant mostly in 20 months horizon.

Secondly, we explore how the external shocks affect the Mongolian price level. We trace out that the external demand shock decreases the price approximately 0.76% after 5 months whereas after 13 months price increases by 0.28% at most. The external supply shock affects on domestic price level significantly as it increases the price by 1.16 % after 6 months and its effect still lasts in the long run. Moreover, external monetary policy shock decreases the price by 1.33% after 5 months. The external shocks have more enduring effect on the price in comparison with the domestic shocks. Therefore, now we can say that the external shocks play in a main role in the price level rather than the domestic shocks.

Third, we analyze which shock mainly attributes the variability of the economic variable of Mongolia. Therefore, we trace out that in the 1-3 months horizon the domestic shocks (especially supply and exchange rate shock) mostly contribute to the price variability while in the long run the external shocks play in the first place by accounting approximately 78% of fluctuation. Briefly, the domestic price fluctuates due to the external monetary policy shock and supply side shock in the long run especially.

Fourth, we check the model robustness using two approaches. First, we change the order of the variables. The model results do not differ more or less and it proves that the model is robust in this cast. The next approach to the robustness of the model is changing the sample period. The result differs moderately but the main remarks are stayed unchanged. In addition, we explain this moderate change by the structural breaks from the financial crisis. Therefore, we can say that the model we employed is robust.

All in all, we conclude that the external shocks significantly affect the price level of Mongolia. Especially we can point out the external supply shock and monetary policy shock. In addition, we ascertain that external shocks have stronger affect on the price level to compare with the domestic shocks. It simply shows that the domestic economy highly dependent on the foreign economic activities.

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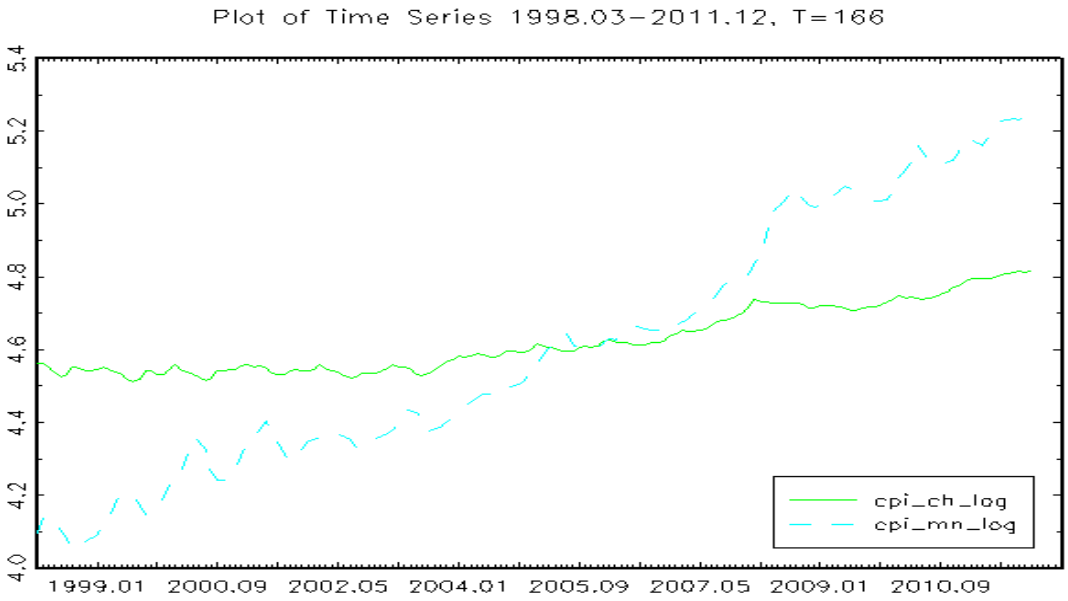
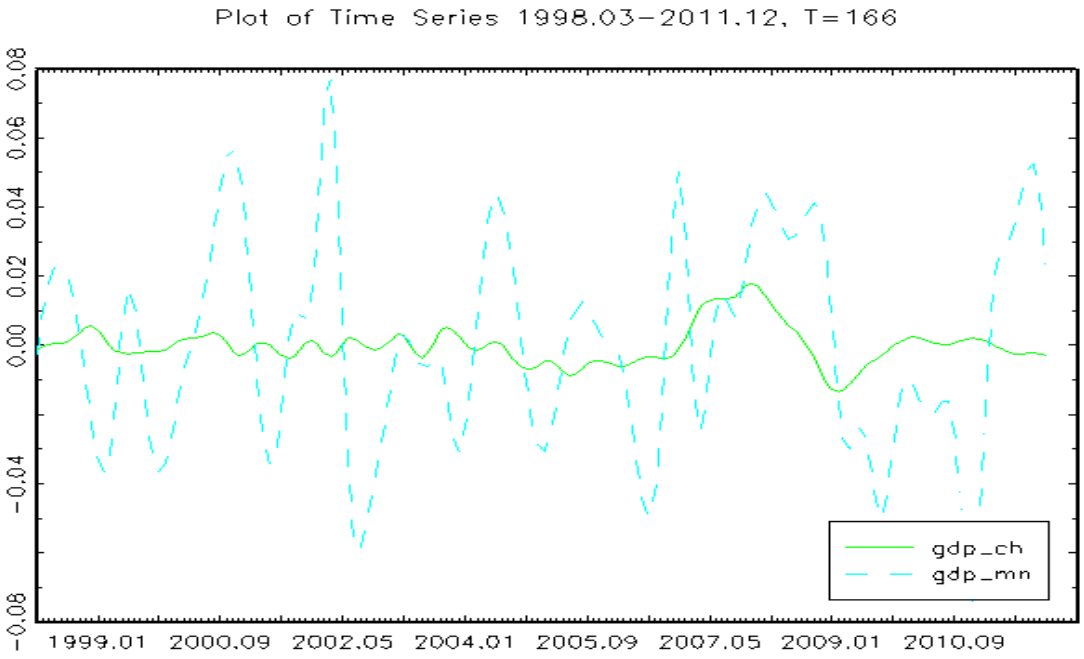
Appendix 1

Time series of the variables

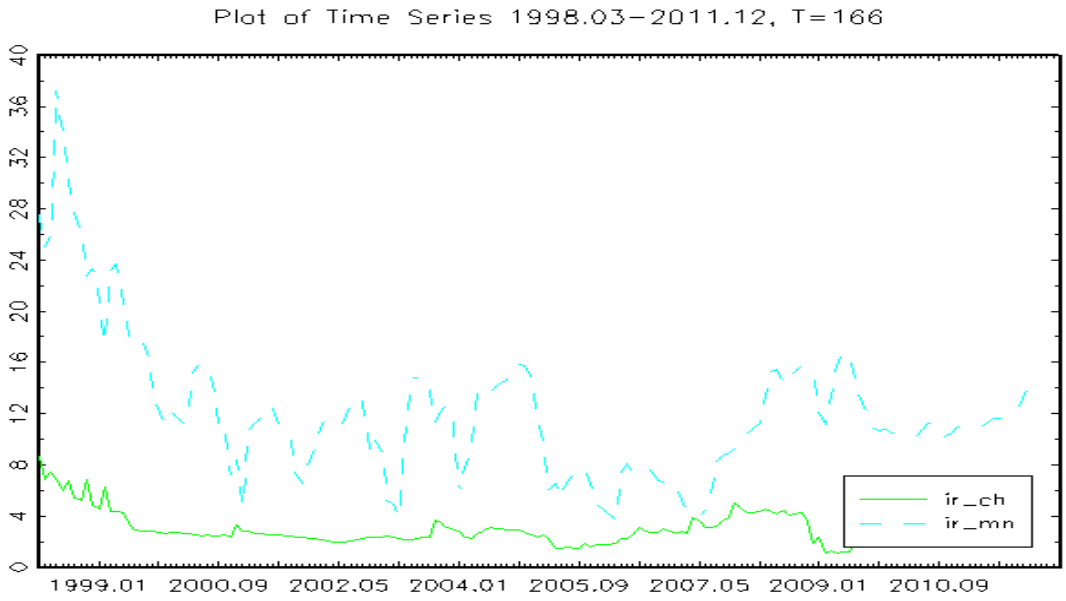
1. CPI of China and Mongolia



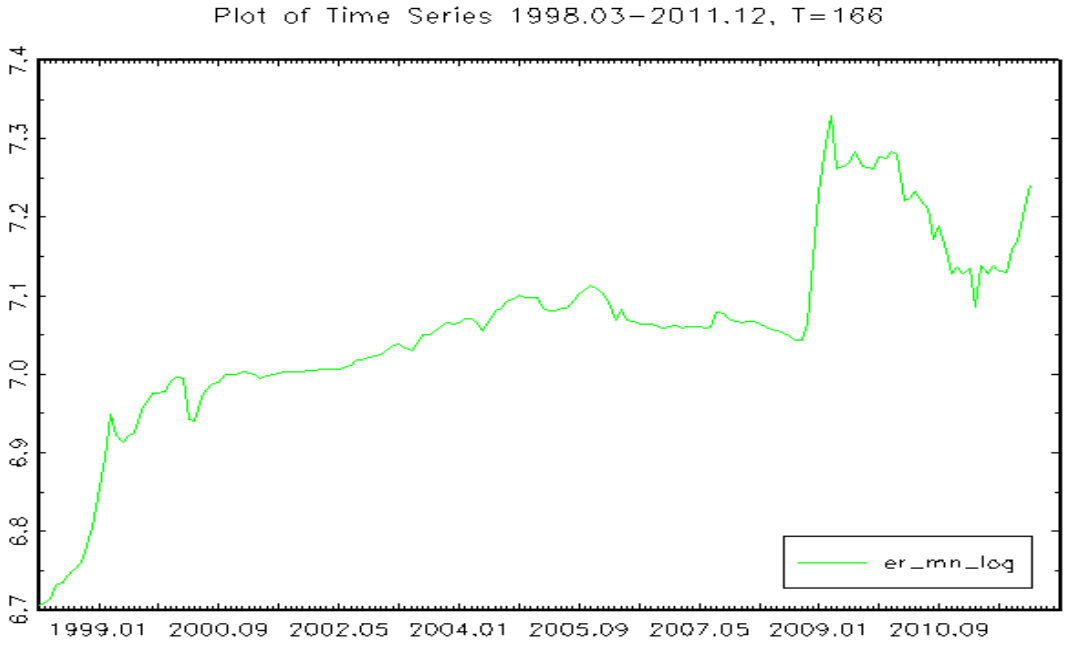
2. Output gap of China and Mongolia



3. Monetary policy rate of Mongolia and China

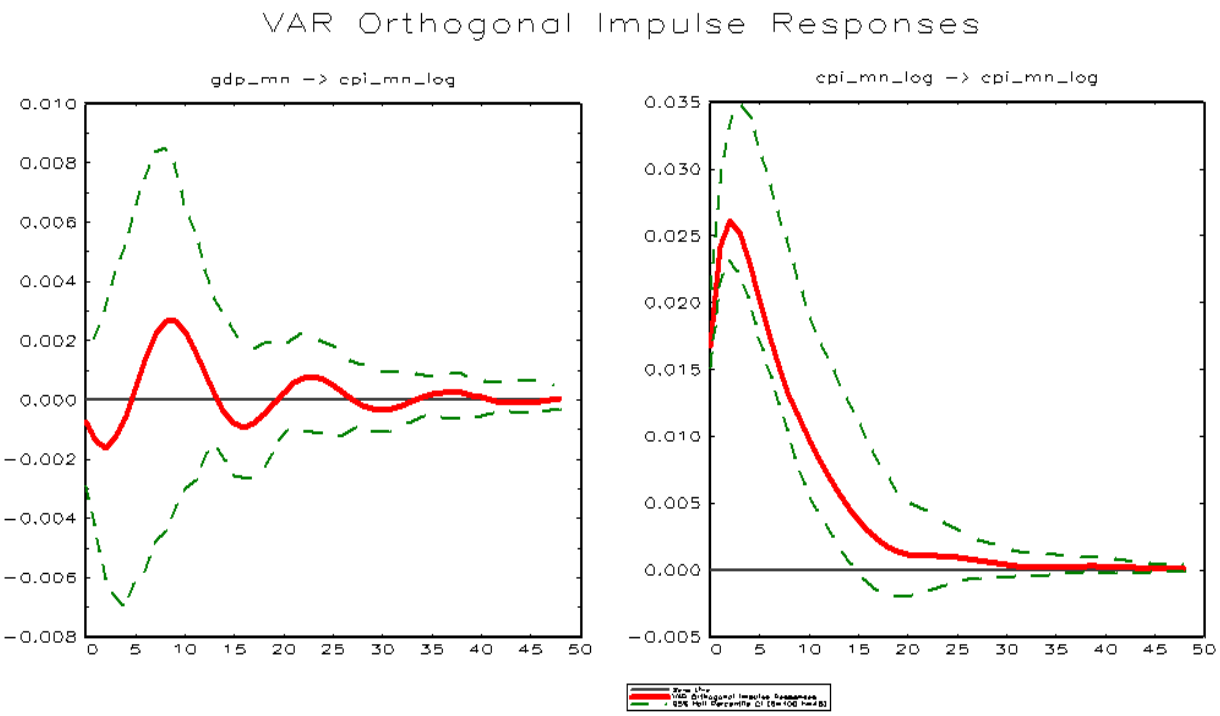


4. Exchange rate of Mongolia

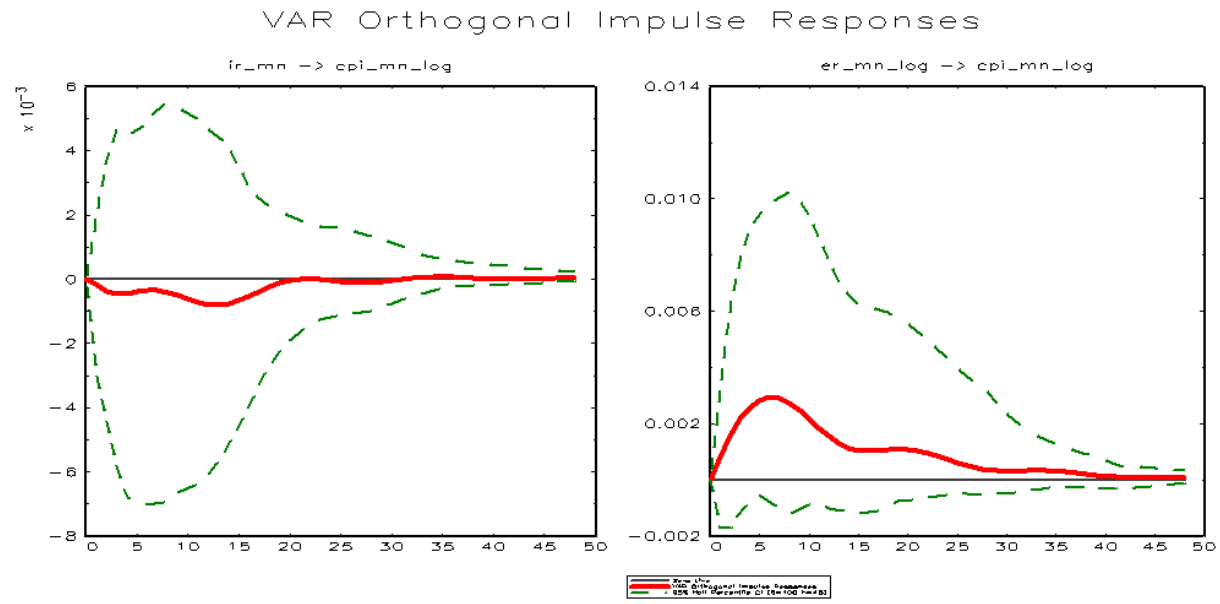


Appendix 2

1. Domestic shock: output gap and CPI to the price level



2. Domestic shock: interest rate and exchange rate shock to the price



3. External shocks: Output gap, CPI, interest rate to the domestic price level